A COMPARISON OF THE BIRD COMMUNITIES OF TWO HIGH COUNTRY LAKES

A thesis

submitted in partial fulfilment

of the requirements for the Degree

of

Master of Science in Environmental Science

in the

University of Canterbury

by

Sarah L. McClymont.

The trees are in their autumn beauty
The woodland paths are dry,
Under the October twilight the water
Mirrors a still sky;
Upon the brimming water among the stones
Are nine and fifty swans.

The nineteenth autumn has come upon me
Since I first made my count;
I saw, before I had well finished,
All suddenly mount
And scatter wheeling in great broken rings
Upon their clamorous wings

W.B.Yeats.
(The Wild Swans at Coole)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

A study was undertaken to document and compare the aquatic bird communities of two high country lakes, Lake Pearson and Lake Grasmere, located in the Cass Basin, Waimakariri Valley, Canterbury.

The two lakes show differences in shoreline structure, riparian communities and humun use patterns. Lake Pearson is regularly used by people for recreation while Lake Grasmere is a Wildlife Refuge and recreation activities are restricted.

Data is gathered on bird abundance and feeding activity over the course of eleven months. The bird communities of these lakes showed differences in species composition and abundance within their community structure with Lake Pearson exhibiting greater species richness and Lake Grasmere greater abundance. These differences were the result of many interactions occurring between lake morphology and component aquatic and terrestrial vegetation, season and life cycle influences and human disturbances to the lakes. Species demonstrated different responses to these factors. Extensive aquatic macrophytes in Lake Grasmere attract large abundances of waterfowl, particularly Black Swans and Canada Geese. The latter species has the potential to significantly add to the nutrient loading of the lake. Species composition and abundance were also influenced by season, with some bird species migrating away from the lakes to escape the harsh winter or to travel to breeding grounds.

Lake Grasmere is important as a moulting site for waterfowl, particularly Paradise Shelduck and as a feeding habitat for the threatened species,

Crested Grebe. Lake Pearson is an important breeding habitat for Crested Grebe but experiences regular disturbance from human recreation.

CHAPTER 1

GENERAL INTRODUCTION

1.1 WETLANDS

(1.1.1) Definition and dynamics

Lakes and their associated wetlands provide important habitats for wildlife, particularly birds, which form a significant part of lake fauna. The varied habitats are utilised by bird species for feeding, breeding, moulting, places to shelter and refuge.

Wetlands are defined in this thesis according to the National Water and Soil Organisation definition: " Wetlands is a collective term for permanently or temporarily wet areas, shallow water and land-water margins. Wetlands may be fresh, brackish or saline, and are characterised in their natural state by plants and animals that are adapted to living in wet conditions " (N.W.S.C.O., 1983).

Wetlands are one of the most biologically productive ecosystems in the world (Williams, 1990, Williams M.J, 1982b). They support a greater diversity of bird species than any other habitats; on average New Zealand wetlands support in excess of 50 species of waterbird (N.W.S.C.O., 1982). Birds that utilise New Zealand wetlands include groups such as waterfowl

(Anseriformes), grebes (Podicipediformes), shags (Pelecaniformes), herons and bitterns (Ciconiiformes), waders, gulls and terns (Charadriiformes) rails (Gruiformes) and the Fernbird (Passeriformes) (Williams M.J,1982a, Sagar, 1982).

New Zealand has less than ten percent of its original available wetland habitat (N.W.S.C.O., 1983). This is due to extensive drainage of wetlands and subsequent conversion to farmland. This has constituted a huge loss of plant and animal species, and wetlands have become one of New Zealand's rarest ecosystems (Burns, 1982).

Wetlands are dynamic both in an evolutionary sense and on a smaller seasonal time scale, and are characterised by continuous succession. This is demonstrated by a gradual increase in productivity over time, or increasing eutrophication. Plants and animals inhabit wetlands during all phases of succession, with continual replacement of communities over time (Williams M.J, 1982b).

Ephemeral or temporary wetlands are highly unpredictable and experience regular cycles of wet and dry periods throughout a year. Alternatively, they may remain dry for many years coming alive as wetlands spasmodically after heavy rains (Ogle, 1991). Birds usually rely on a number of available habitats for feeding within a wetland complex rather than on one individual wetland (Skagen & Knopf,1994).

(1.1.2) International wetland network and migration

Migratory species are dependent on a chain of wetlands for their survival (N.W.S.C.O., 1982). In North America, millions of waterfowl migrate survival (N.W.S.C.O., 1982). In North America, millions of waterfowl migrate from their breeding grounds in the northern freshwater wetlands of the United States and Canada to the Gulf Coast, California and Mississippi valley where they spend the winter. Small wetlands located along these major migration paths are important stops where birds can briefly feed and rest (Williams, 1990). New Zealand is a necessary link in the population survival of some international species (Sagar, 1982) and New Zealand wetland habitats are used by tens of thousands of arctic and subarctic waders and terns each summer. Species include the bar-tailed godwit, knot, stint and sandpiper, which migrate from Siberia and Alaska to escape the Northern Hemisphere winter before returning to their native country to breed (Sagar, 1982).

(1.1.3) Role of birds in wetlands and lakes

Birds play an important role in wetland systems as they have the potential to impact on the biota present and lake trophic status through feeding and the importation of nutrients into the lake. The use of waterfowl as indicators of lake trophic status has been investigated but with limited results (Suter, 1994). Conclusions have been that complexity of waterfowl and wetland ecosystems does not lead to clear relationships (Suter, 1994). This problem requires further investigation. Birds are an important vector in transporting nutrients into water bodies via faeces. This process over time, can alter the water bodies trophic state (Kerekes, 1994).

Wintergreen Lake, a glacial lake near Kalamazoo, Michigan, receives more than 4400 dry kg of faeces from thousands of migrant Canada Geese

(*Branta canadensis*). Geese and duck numbers, and their subsequent nutrient loading, are highest during the October-December migration. During this period, waterfowl added 60% or 52.5kg of their total annual phosphorus load to Wintergreen Lake. This has had the effect of producing a lake that is eutrophic to hypertrophic (Manny et al, 1994). Other nutrients from eggshells and bird feathers may enter wetlands during breeding and moulting periods respectively. Although these inputs may be small compared to bird waste nutrient loading, they may be significant enough to increase the nutrient status of a small lake (Dobrowolski et al, 1976).

(1.1.4) Wetlands as habitats for New Zealand birds

Birds that utilise wetlands occupy a particular habitat type that represents one phase in the wetland succession. A single wetland will contain all of the various successional stages at the one time resulting in high diversity of plant and animal life (Williams M.J, 1982b). A detailed study of the habitat requirements of wetland birds has been made on Lake Wairarapa, by the former Wildlife Service (Moore et al 1984).

In New Zealand wetlands the open water zone is used by shags, grebes and some waterfowl. The former two bird groups and the New Zealand Scaup (*Aytha novaeseelandiae*) are diving species. Scaup and grebes prefer water of high clarity (Williams M.J,1982a, Sagar, 1982, Neilson, 1987).

The shallow marginal zone of wetlands is utilised by waders, herons and many other waterfowl. For example the Southern Crested Grebe floating nests on partially submerged shore vegetation.

Regions of swamp are inhabited by rails, the New Zealand Fernbird (*Bowdleria punctata vealeae* (North Island), *Bowdleria punctata punctata* (South Island)), and the Australian Bittern (*Botaurus poiciloptilus*). Swamp and other sections of the zone between water and land, provide nesting habitat for waterfowl and wading species as well as bird species that reside there permanently. Shags and herons nest in trees along the lake shoreline. The shallow marginal zone and transition region between wet and dry land contains the majority of wetland species (Williams M.J, 1982a,b).

Wetlands provide valuable moulting habitat for birds, particularly waterfowl species. Moulting renders the birds flightless and therefore increases their vulnerability to predation. In New Zealand large numbers of Paradise Shelduck (*Tadorna variegata*) congregate on wetlands between January and March to complete their annual moult (Williams M.J, 1979).

1.2. HUMAN IMPACT ON LAKES AND WETLANDS

New Zealand lakes and wetlands are used both for commercial and recreational purposes by humans. Vast areas of wetland have been lost through drainage and subsequent conversion to productive farmland and increasingly for residential development.

(1.2.1) Agriculture

Agricultural development and practices continue to impact on

Agricultural development and practices continue to impact on wetlands. Development of pasture to the water's edge of a wetland and subsequent grazing by stock, has led to the elimination of the transition zone in some areas. This is the region that contains the greatest diversity of flora and fauna, including birds (Williams M.J,1982b). Nutrient run-off from fertilised paddocks to adjacent wetland ecosystems affects trophic status and accelerates the eutrophication process.

(1.2.2) Lake level manipulation

Many lakes in New Zealand have been used for hydropower electricity generation. Fluctuating lake levels associated with this usage disturb Crested Grebe nests which are susceptible to either flooding or stranding (Westerskov, 1971).

(1.2.3) Recreation

Recreational activities feature highly on New Zealand lakes and wetlands which provide locations for a variety of leisure pursuits, particularly water sports. Vigorous and active sports are not always compatible with the needs of the resident wildlife (Fox et al, 1994), and a conflict of interest can arise between users. Activities such as motorised boating, water and jet-skiing create significant disturbance to birds in the form of water level fluctuations, swash and increased noise levels. For example water disturbance created by motorised boating has resulted in the destruction of Crested Grebe nests (Westerskov, 1971, Marchant & Higgins, 1993). Fox et al (1994) demonstrated that Pochard (*Aytha ferina*) were not present on lakes in south central Britain that contained power boating or jet-skiing.

Seemingly less intrusive recreational activities can still impact on aquatic birds. The launching of a single, sailing dinghy was reported to cause the departure of a Pochard flock comprising 5-800 birds from a large lake (Fox et al 1994). Canoeists moving slowly close to shorelines of a Michigan lake in Ottawa National Park disturbed incubating common loons (*Gavia immer*) (Caron & Robinson, 1994).

Lakes have suffered from major eutrophication problems due to direct disposal of sewage into waterways. This has detrimental effects on water quality which ultimately impacts on the resident wildlife.

1.3 HIGH COUNTRY LAKES

High country lakes are distinctive environments because of their geographic location, high altitudes, and associated harsh climates. These combined factors produce a highly fluctuating environment in which resident animal and plant species have to be adaptable to survive. In New Zealand, some high country lakes are very important resources for hydropower generation. Secondary uses include irrigation for agricultural purposes and human recreational activities. There has been little scientific research on birds in high country lakes in New Zealand and most studies have focused on single species, for example the Southern Crested Grebe (O'Donnell, 1980) and the Black Stilt (*Himantopus novaezealandiae*) (Pierce, 1982).

1.4 STUDY LAKES: LAKE PEARSON AND LAKE GRASMERE

The South Island of New Zealand has numerous lakes, many of which are located in the high country and are glacial in origin. Lakes Pearson and Grasmere (Fig 1.0, 2.0, Plate 1, 2), located in the upper Waimakariri River catchment, Canterbury were created as a result of the action of the Waimakariri glacier during the late Pleistocene period (Gage 1959). Post-glacial processes such as outwash fans have modified the lakes and culminated in their present physical form.

Both lakes lie in close proximity to the Southern Alps, which have a strong influence on the weather patterns experienced by the lakes (Greenland, 1977). Orographic rainfall and strong northwest winds, are frequently experienced and high ultra violet exposure and very harsh frosts are also climatic features of the high country (Greenland, 1977). These weather variables create natural disturbance events such as storms, drought, and lake freezing which impact on bird communities.

Despite having similar origins the two lakes exhibit distinct physical differences particularly in shoreline structure. Lake Pearson has extensive wide, gently sloping,gravel beaches along its undulating shoreline. Lake Grasmere, in contrast, has little beach formation but considerable narrow, abrupt shoreline with steep banks, particularly along the eastern side. Both lakes experience human recreation and agricultural impacts. Lake Pearson receives greater disturbance from human recreation, while Lake Grasmere experiences more agricultural impacts.

(1.4.1) Agriculture

European settlers first entered the Cass district in search of potential farmland in 1857. Homesteads were established on Grasmere and Craigieburn sheep runs by late 1858. Craigieburn station incorporated the present Flock Hill station which borders Lake Pearson (Burrows, 1977). Both lakes are surrounded by land under agricultural production. Wetlands were drained and converted into farmland. In later decades fertiliser applications occurred along with the establishment of irrigation schemes to further increase the productivity of the land (Burrows, 1977). As a result of these farming practices the catchment of Lake Grasmere is the most highly developed area in the upper Waimakariri basin (N.C.C.B.& R.W.B. 1986). Nutrient loading into the lakes increased as a result of run off from adjacent fertilised paddocks and influx of Canada Geese (*Branta canadensis*) faeces. Flocks of this introduced species feed on crop paddocks and then roost on lakes (Potts & Andrew, 1991). Geese have been a major pest within the district for at least two decades (E.Chapman, Grasmere Station, pers.comm). Access to lake shores by farm stock provides the opportunity for further nutrient addition from animal faeces. All of these factors lead to the increased eutrophication of the lakes (N.C.C.B.& R.W.B.1986). This is particularly noticeable with regard to Lake Grasmere.

(1.4.2) Recreation

The Waimakariri valley is heavily utilised by people for a variety of recreational pursuits. Outdoor activities are undertaken in the surrounding

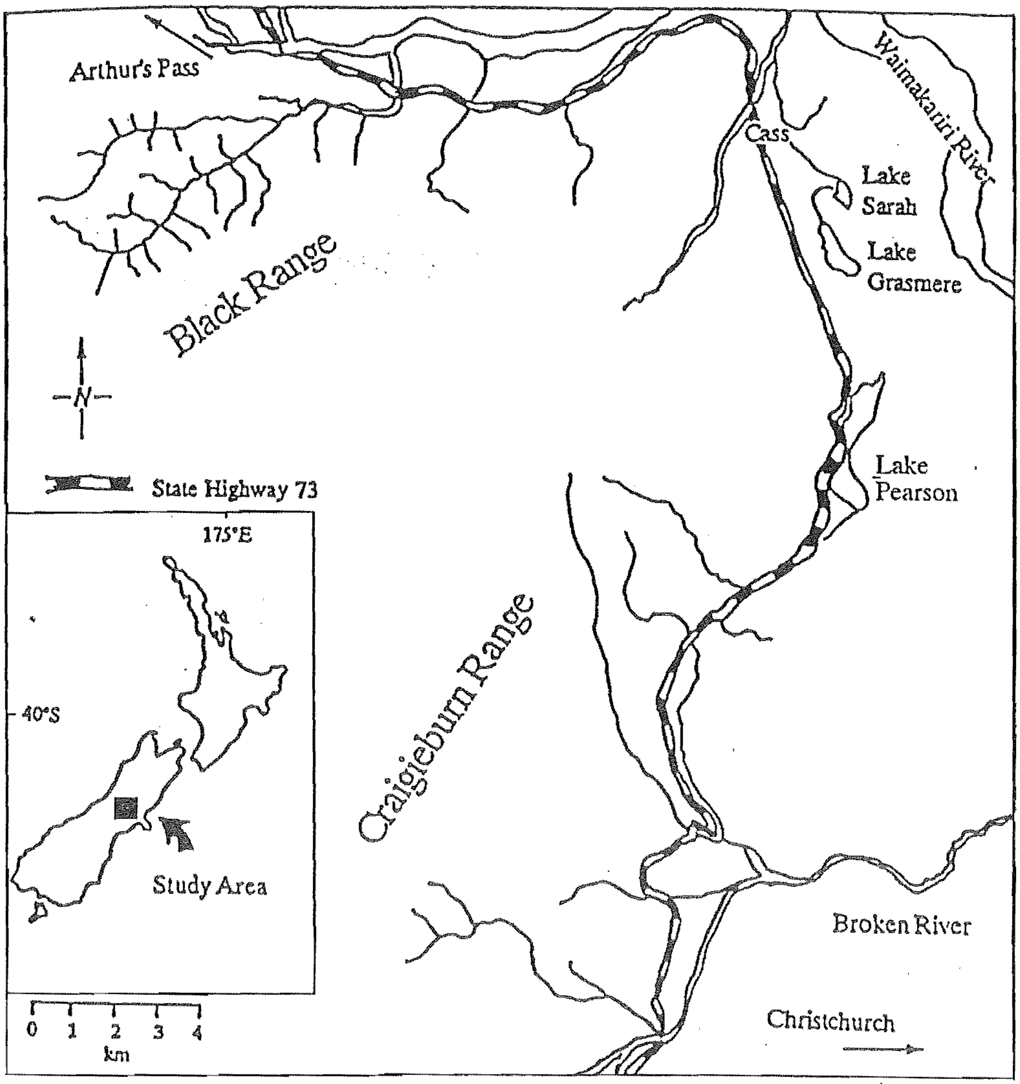


Figure 1.0 Map of South Island, New Zealand, showing Lake Pearson and Lake Grasmere. Map adapted from Death (1991).

Plate 1: Lake Pearson, Canterbury, New Zealand.

Plate 2: Lake Grasmere, Canterbury, New Zealand.

mountains and on the Waimakariri River. Lakes Pearson, and to a lesser extent Grasmere, are also important sites.

State highway 73, the major road that links the east and west coasts of the South Island, is close to both lakes, and runs alongside the southwest shore of Lake Pearson. This highway provides easy access to the lakes for large numbers of people being busy with traffic throughout the year, especially during school and public holidays, the ski season and the Christmas and New Year break (Transit N.Z. pers. comm). Both lakes are only 90 minutes drive from Christchurch.

Lake Pearson is regularly used for camping, angling, jet boating and other water sports. Four private fishing cottages are located around the perimeter of the lake. A picnic area with toilet facilities is present at the northern end of Lake Pearson. The Waimakariri high country lakes account for approximately 13% of trout angling effort in the catchment, with Lake Pearson being used most often. It received 44% of all lake angling visits to the high country lakes of the upper Waimakariri (N.C.C.B.& R.W.B., 1986), and is the only lake in New Zealand which still contains the introduced North American lake trout (*Cristovomer namaycush*) (Hutchinson, 1981).

Lake Grasmere is a designated Wildlife Refuge and this restricts some recreational activities. Motorised boating is prohibited without a permit. This lake is again a popular fishing location, ranking second to Pearson (N.C.C.B.& R.W.B., 1986), and is used for camping and picnicking.

(1.4.3) Local scientific research

Both lakes have been the subject of scientific studies, partly due to the close proximity of the University of Canterbury field station located in the nearby small railway village of Cass. Limnological research has been undertaken on the lakes providing a good background of information. Stout (1969, 1972, 1975, 1976, 1984) in particular, has undertaken extensive limnological research on Lakes Pearson and Grasmere. However, there has been no detailed study focusing on the bird life of Lakes Pearson or Grasmere. The Department of Conservation has a data base of bird counts recorded from the upper Waimakariri lakes (including Lakes Pearson and Grasmere) from late 1987 to mid 1993 but the collection of bird count data has now ceased. This database provides a history of bird abundances, and resident and migratory species within the Waimakariri lakes, including Lakes Pearson and Grasmere and has served as a source of information for Chapter 5.

1.5 THESIS AIMS

The two, main aims of my research were to a) document and compare the bird communities of Lakes Pearson and Grasmere over the course of a year, b) attempt to account for differences between the two bird communities. Objectives were defined in order to answer the above questions.

(1.5.1) Bird Communities

I required information pertaining to the abundances of birds on the lakes and species composition throughout the year. Habitat requirements of birds needed to be assessed and observed over the course of the year to evaluate changes in habitat use.

(1.5.2) Physical characteristics

Physical variables of the lakes needed to be surveyed and measured to gain a description of the study area and bird habitats.

(1.5.3) Disturbance and Impacts

I assessed relative disturbance levels (both natural and human induced) and their impacts on the composition of the bird communities. This included obtaining information on numbers of people visiting the lakes and observing their recreational activities.

CHAPTER TWO

METHODS

Field methods and experimental design were devised partly with reference to the Lake Wairarapa habitat requirement study (Moore et al., 1984).

2.1 FIELD METHODOLOGY

Bird observations were made with the aid of 12 x 50 binoculars and a 60 mm telescope with tripod (Plate 5). Positive bird identification was confirmed with the use of Moon's field guide (1992). Transport to the sites over the summer and autumn counts was by mountain bike and on foot to both lakes. During the winter months transport was by car (for safety reasons) and for more inaccessible sites, mountain bike and foot. It was attempted at all times to keep disturbance to all bird species as low as possible.

(2.1.1) Lake Pearson

State Highway 73 passes along the northwest edge of Lake Pearson. There are several gravel vehicle tracks that extend off the main highway along this side of the lake and provide many view points enabling bird counts to be made along or above the lake shoreline. There are established farm tracks along the northern and southern edges. Access to the northern edge was by mountain bike, foot or occasionally car. Access to the southern end of the lake was by foot only. Bird counts were made along the shoreline or in elevated positions which allowed good views but did not disturb bird life.

(2.1.2) Lake Grasmere

All bird counts were made from the ridge and toe of Long Hill which is along the northeast side of Lake Grasmere (Fig 2). The Long Hill ridge allowed good views across the lake including the popular camping area at the southern end of the lake. Daily visitors to the lake were easily observed from the ridge. Farm activities immediately adjacent to the lake on Grasmere and Craigieburn Stations were also easily observed from the ridge top.

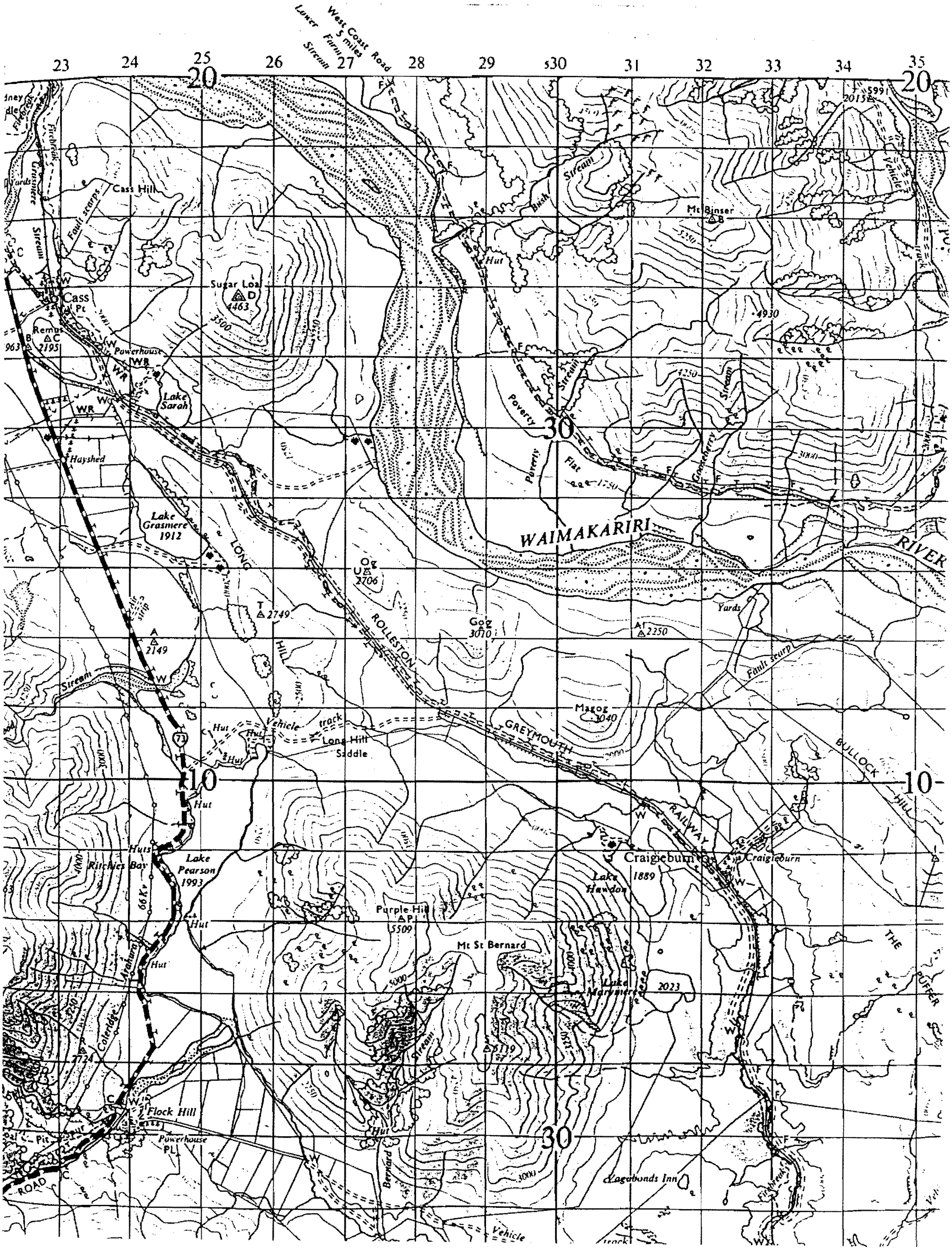
2.2 EXPERIMENTAL DESIGN

The bird populations of Lakes Grasmere and Pearson were sampled in accordance with a completely randomised block model of experimental design. Both lakes were sampled in an identical manner.

(2.2.1) Sampling Sites

Each lake was split into five sampling sections or sites. Study sites were determined by parameters such as lake depth, surrounding vegetation type and ease of access. The ability to obtain accurate bird counts with binoculars and a telescope within a limited time frame was also considered. Moore et al., (1984) divided Lake Wairarapa into sampling sites in a similar fashion. Sites could be easily distinguished from one another with the use of

Figure 2.0: Topographical map of Lake Pearson and Lake Grasmere. NZMS1 S66



landmarks such as peninsulas or groups of prominent trees (see Fig 2.1, 2.2, Plates 3, 4).

Habitats that the birds are utilising during the sampling time are described from a detailed categorised list. This list contains six categories including wetland type, location on wetland, description of cover on wetland location, substrate type, water speed, depth, colour and width (see Appendix B). A detailed habitat description is recorded for each bird species as a result. This habitat classification method was used extensively by Moore et al (1984) on the bird communities of Lake Wairarapa. This method was employed to describe various habitats along the lake and their margins and to determine the role they play with regards to the bird communities.

(2.2.2) Bird counts

Bird counts (both abundance and activity) were made twice a day, at sunrise and sunset, but with each lake being sampled just once a day. For example, if Lake Pearson was visited in the morning, Lake Grasmere would be sampled during the evening. On the second day, Lake Grasmere would be sampled during the morning and Lake Pearson in the evening. This choice was randomised in two-day blocks. Each lake was sampled six times per month thus entailing collection of three morning and evening counts. Bird abundances and activity counts were gathered in each of the five sites within the chosen lake during a sampling session.

Sites were visited in a random order (this determined the order sites were to be visited) on a daily basis in each month. Thirty minutes per site was allocated to count bird abundance and activity and to travel on to the

Plate 3 : Sampling sites of Lake Pearson.

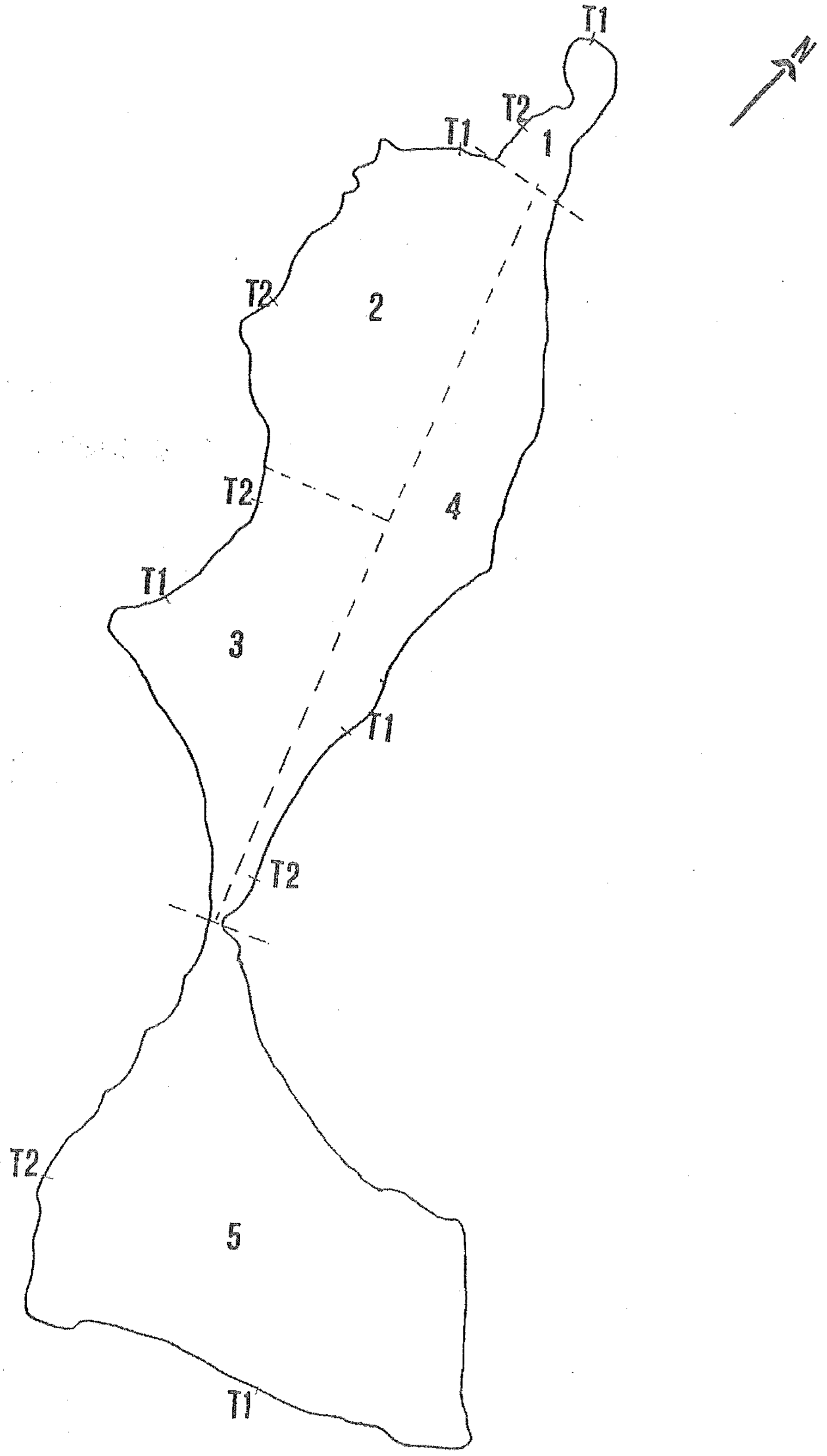


Figure 2.1 : Lake Pearson with sampling sites and lake profile transects shown. 'T' indicates transect location

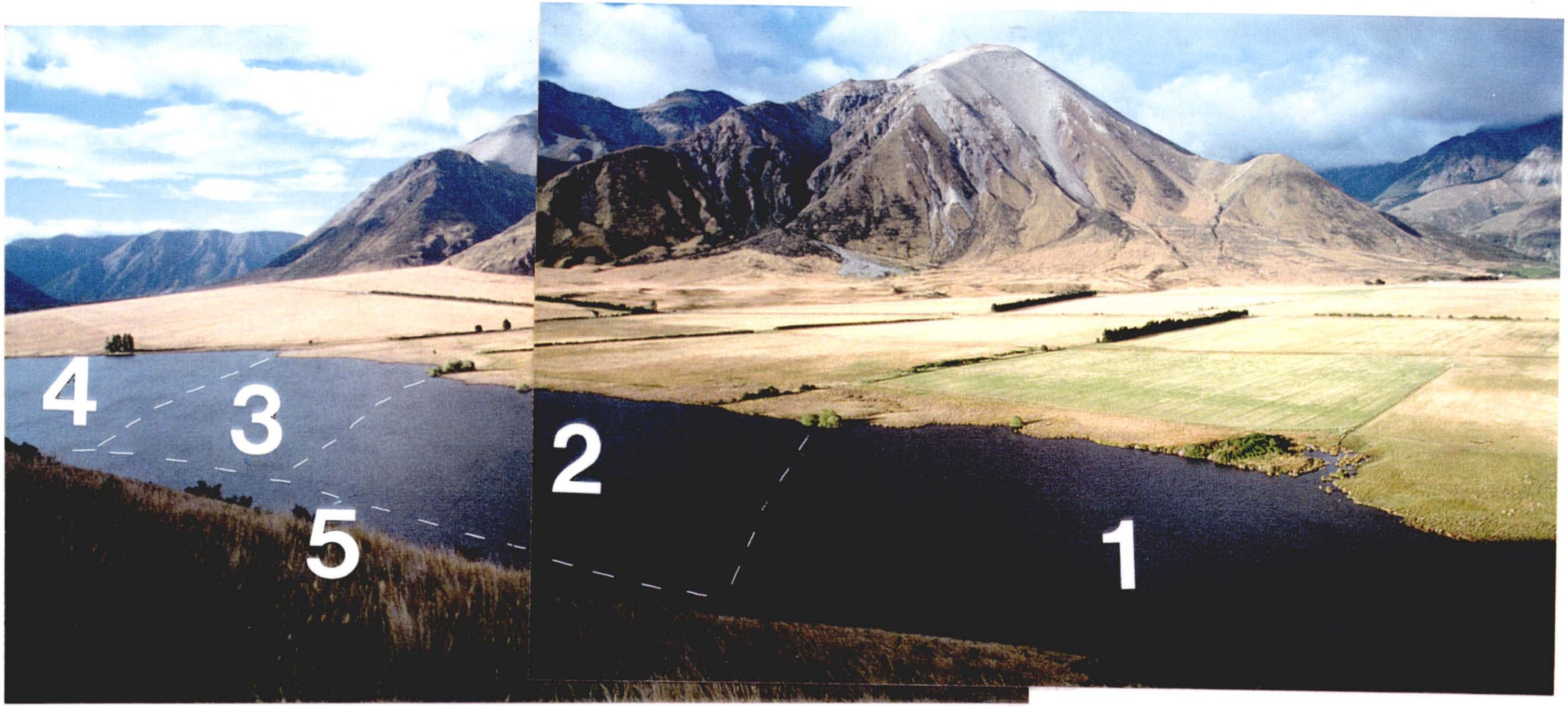


Plate 4: Sampling sites of Lake Grasmere.

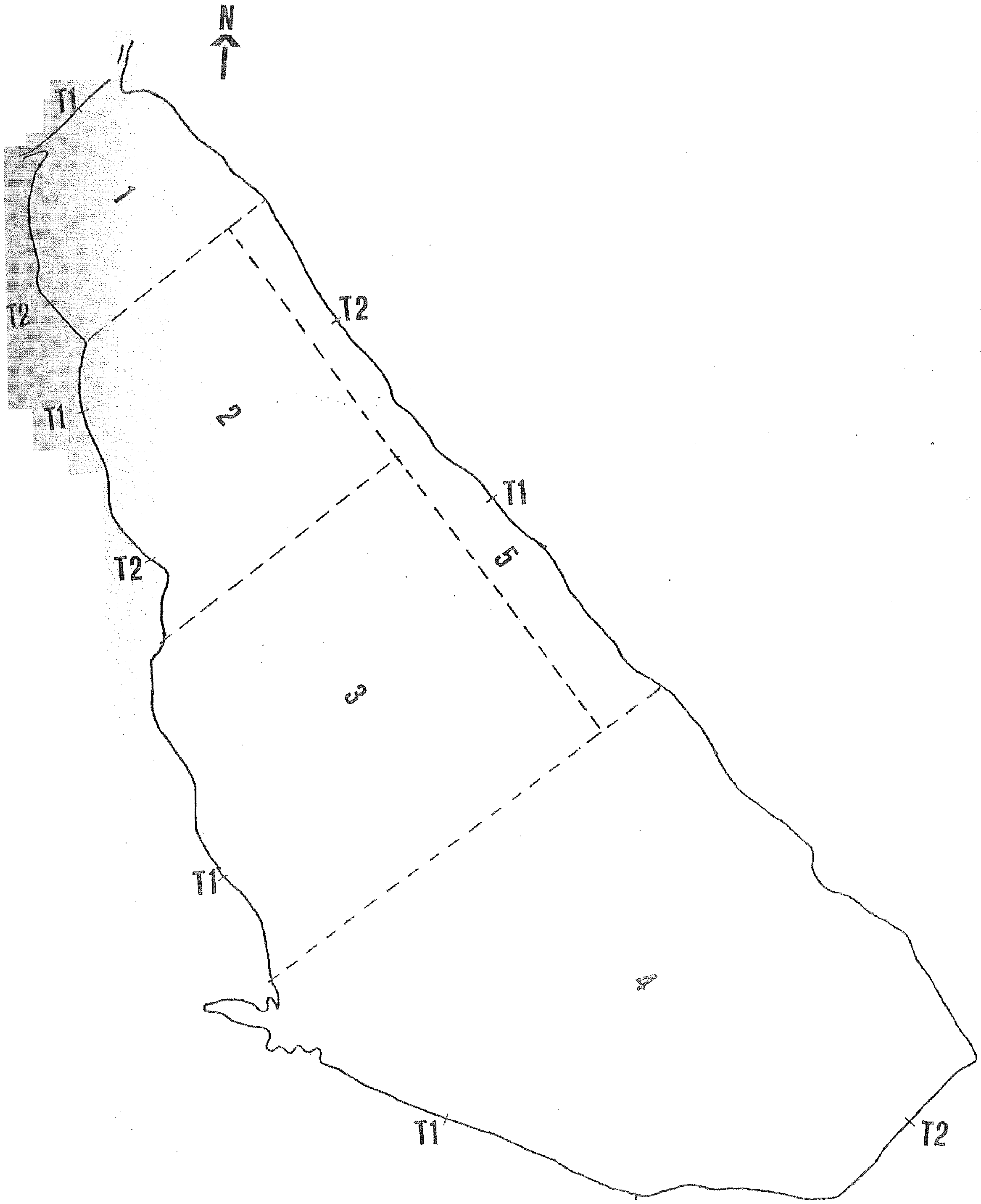


Fig. 2.2: Lake Grasmere with sampling sites and lake profile transects shown. 'T' indicates transect location.

Plate 5: Counting birds with 60mm telescope, Lake Pearson.

Plate 6: Climate station located at Cass Field Station, Department of Plant and Microbial Sciences, University of Canterbury.

next site. Times were synchronised with sunrise and sunset over the course of the year. For example, in Fig.2.3, during the month of October, the first morning count of Lake Pearson was at site 5 at 7:30 am. That evening , a sunset count would be made at Lake Grasmere beginning at 6:30pm, site 2. At each site a count of the number of birds present in each species on the water and lake margin was made. The activity of birds was observed and recorded into one of two categories: a) roosting, loafing and washing (preening), b) feeding and foraging (this included aerial foraging where this could be identified). Bird species flying over the site during the sampling time are recorded.

(2.2.3) Final Data Set

Bird count and activity data were collected on a monthly basis from March 1995 through to January 1996. Incomplete data sets were gathered for the months of March, April and September, and no data were collected during July 1995 (due to ill health). However the data analysis was able to deal with the presence of missing data (see below).

2.3 DATA ANALYSIS FOR BIRD ABUNDANCE AND FEEDING DATA

(2.3.1) Bird abundance data

The effects of lake, site and month on bird abundance were tested using generalised linear models. Generalised linear models are a family of statistical analysis approaches which allow for different types of predictors and responses. Predictors ("independent variables") can be classed factors

Figure 2.3 Experimental Design

October

Lake Grasmere (am)

Times

	730	800	830	900	930
Day 1	5	1	3	4	2
Day 2	4	3	5	1	2
Day 3	1	5	4	3	2

Lake Pearson (am)

Times

	730	800	830	900	930
Day 1	5	4	1	3	2
Day 2	4	3	5	1	2
Day 3	4	5	2	1	3

Lake Grasmere (pm)

Times

	1500	1530	1600	1630	1700
Day 4	2	3	4	5	1
Day 5	3	4	5	2	1
Day 6	5	2	3	4	1

Lake Pearson (pm)

Times

	1500	1530	1600	1630	1700
Day 1	5	3	4	1	2
Day 2	1	4	2	5	3
Day 3	4	3	1	2	5

as in analysis of variance, continuous variables as in regression, or a combination as in analysis of covariance. Responses ("dependent variables") can have one of many error distributions, including the normal distribution as in standard ANOVA and regression. Each error distribution is associated with an appropriate link function which is somewhat like a normalising transformation (Crawley, 1993).

In this particular case, the response, bird count per species was taken to have a Poisson distribution, requiring a log link function. As for the predictors, all were factors, site was taken to be nested within lake, with month orthogonal, so that the full set of effects and interactions was: month, lake, site within lake, month by lake and month by site within lake. Each effect was tested against the Chi-square statistic, as required for a Poisson model. All analyses were performed on the S-plus statistical package version 3.3 (StatSci Inc. 1995).

(2.3.2) Bird activity data

Bird activity was also tested using generalised models. However the number of birds performing each activity was not analyzed as this would have confused activity with abundance. Instead the proportion (0-1) of birds feeding was used as the response variable and this proportion was taken to have a binomial error distribution requiring a logistic link function. The predictors were month, lake, site within lake, month by lake and month by site within lake, each of which was tested against the Chi-squared statistic as appropriate for a binomial model. All analyses were performed using S-Plus v.3.3 (StatSci 1995).

2.4 LAKE PROFILES AND AQUATIC AND TERRESTRIAL VEGETATION SURVEYS

In order to describe the sampling sites in detail, shoreline structure was investigated and the aquatic and terrestrial vegetation communities were surveyed.

(2.4.1) Lake Profiles

Shoreline profiles were completed in all sites of both lakes. Two transects were completed in the majority of sites. Site 3 of Lake Grasmere was the exception, with only one profile transect able to be completed at this site due to the presence of thick soft mud which made field work extremely hazardous. The transects in sites 1, 2 and 3 of Lake Grasmere were short for the same reason.

(2.4.1.1) Lake Profile Investigation Methods. A tape measure was run perpendicular to the shore from the base of the bank and extended into open water as far as was physically possible utilising wading equipment. Water depth measurements were taken at regular 0.5 metre horizontal intervals. From these measurements, the slope of the shoreline along the transect could be calculated.

(2.4.1.2) Substrate Survey.

Shoreline and benthic substrates were observed along the transect line. Changes in size and structure of substrate were noted along the transect line. Length measurements were taken of ten pebbles and/or rocks within one metre either side of the transect line if they were present where a visible change in substrate size occurred.

(2.4.1.3) Aquatic Vegetation Survey

Aquatic vegetation that was in the path of the transect line, was observed and depth and distance from the shore recorded. Samples were taken and identified (in laboratory conditions) at the University of Canterbury. Plant identification (both aquatic and terrestrial) was confirmed with the use of Johnson & Brooke (1989), Poole & Adams (1990), Wilson & Galloway (1993), Wilson (1994,1993).

(2.4.1.4) Terrestrial Vegetation

Terrestrial vegetation was identified to species level one metre either side along a twenty metre transect extending from the base of the bank, into the surrounding catchment. Samples were taken and changes in plant species noted and plant communities were identified.

2.5 RECREATION

The numbers and activities of people observed visiting the lakes during sampling periods were noted.

2.6 METEOROLOGICAL DATA

Meteorological data were collected from two sources. The weather station located at the field research station at Cass (Plate 6) provided daily measurements of precipitation, maximum and minimum temperature, mean wind speed, and cloud cover during field visits. Daily precipitation measurements were obtained from an automatic recording device at a weather station located along the northern end of Lake Grasmere by the Canterbury Regional Council.

Water level measurements were recorded from staff gauges located at Lakes Grasmere and Pearson (Plates 7,8). The staff gauge at Lake Grasmere was installed by the Canterbury Regional Council during 1985. A staff gauge was installed at the northern end of Lake Pearson by my field assistant and myself in March 1995. Water level recordings were made during each field visit.

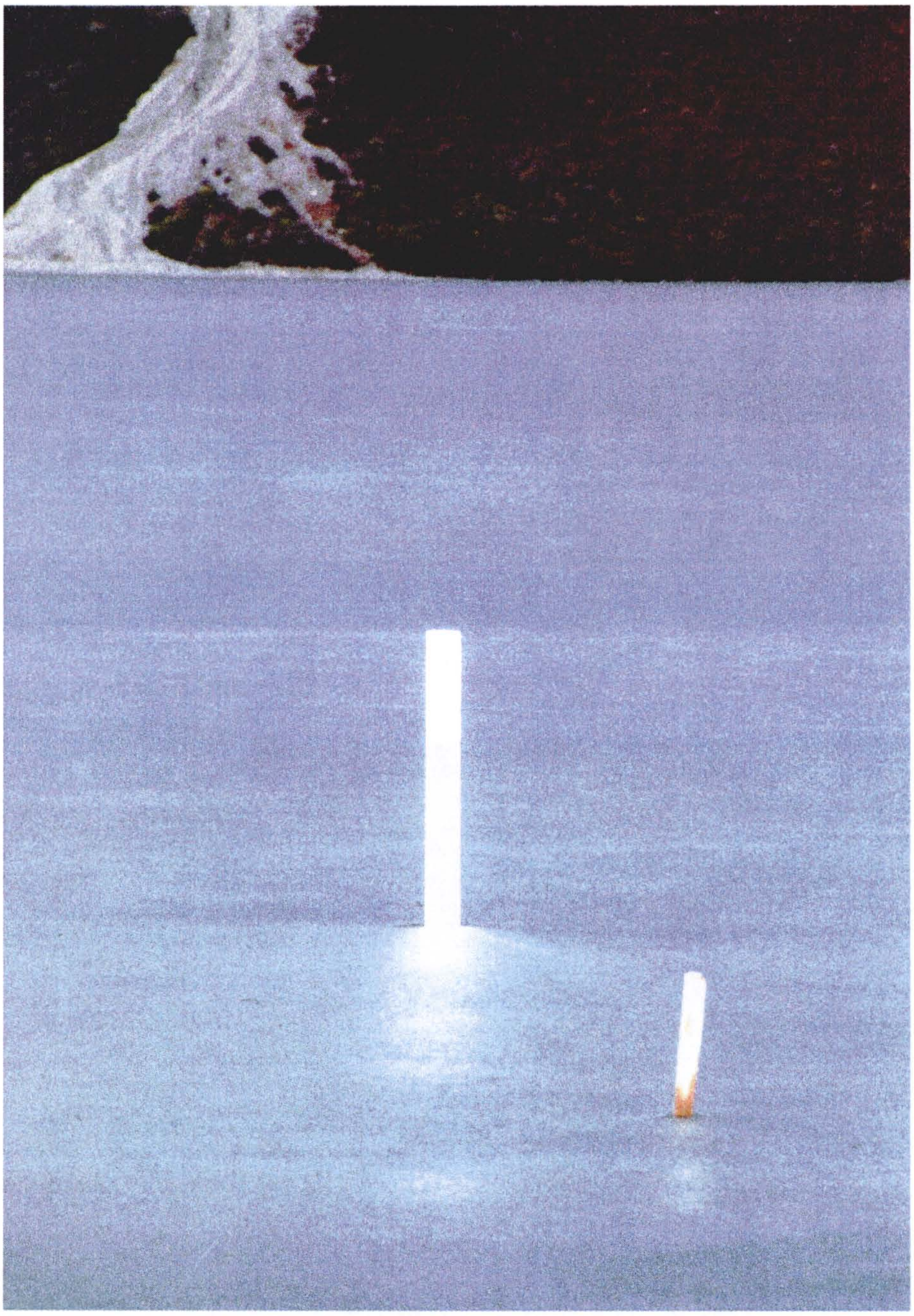


Plate 7: Staff gauge, Lake Pearson (embedded in ice)

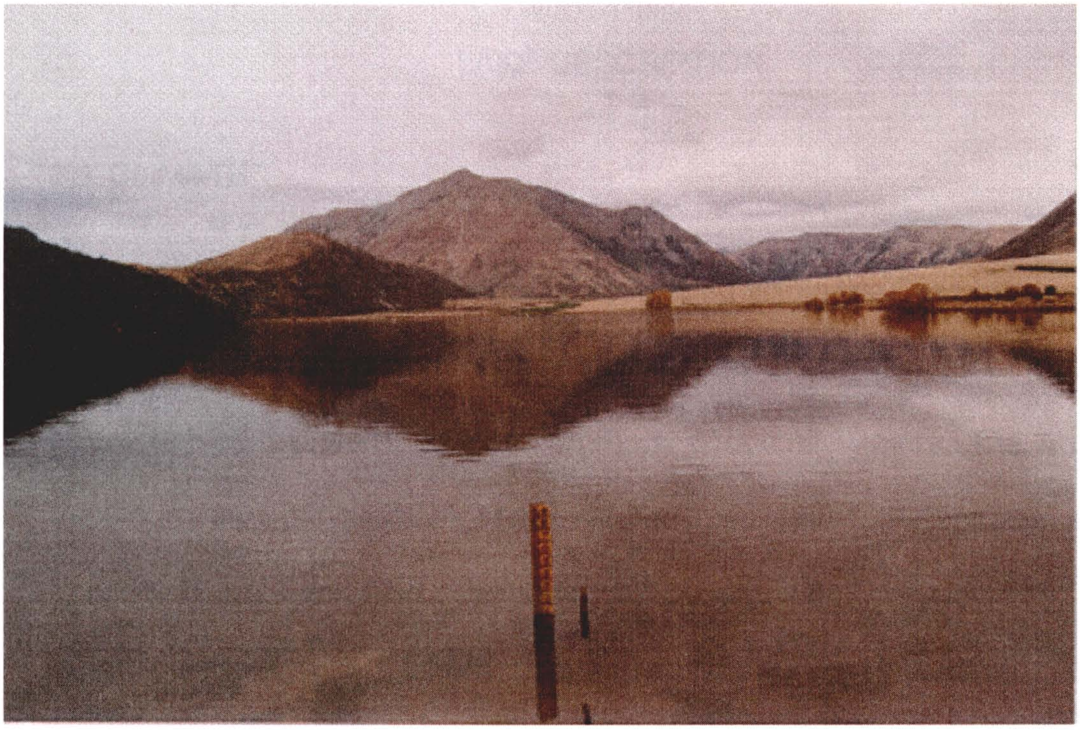


Plate 8: Staff gauge, Lake Grasmere.

Plate 9: Frozen surface of Lake Pearson (August 1995).

CHAPTER THREE

LAKE DESCRIPTION

3.1 CLIMATE

Lakes Pearson and Grasmere are located within the Cass intermontane basin. These high country basins exhibit their own weather patterns, characterised by warm to hot summers and cold winters. The absolute maximum and minimum air temperatures recorded at the weather station located at the Cass field station are 37 ∘ C and 16 ∘ C respectively. Mean monthly air temperatures from the same station during 1961-63 ranged from 15.7 ∘ C in February to 1.6 ∘ C in July (Greenland, 1977). In this study, weather data were collected from the weather station at the Cass Field Station (see Plate 6) from October 1994 to January 1996. Variables recorded included maximum, minimum and current air temperatures, windrun and direction, precipitation and cloud cover. During this data collection period, maximum mean air temperature and minimum mean air temperature was in February and in July respectively (Fig 3.0).

Ground frosts occur approximately 150 times a year (Shanks et al., 1990). Frost intensity is variable between years. The winter of 1995 was considered to be colder than average. The surfaces of Lakes Pearson, Grasmere and Sarah all froze over and remained in that state for approximately two to three weeks with intermittent periods of thawing (Plates 9,10 and 11). Annual sunshine hours at Cass are approximately 1600.

The Cass basin is located within a steep rainfall gradient. Mean annual

Figure 3.0

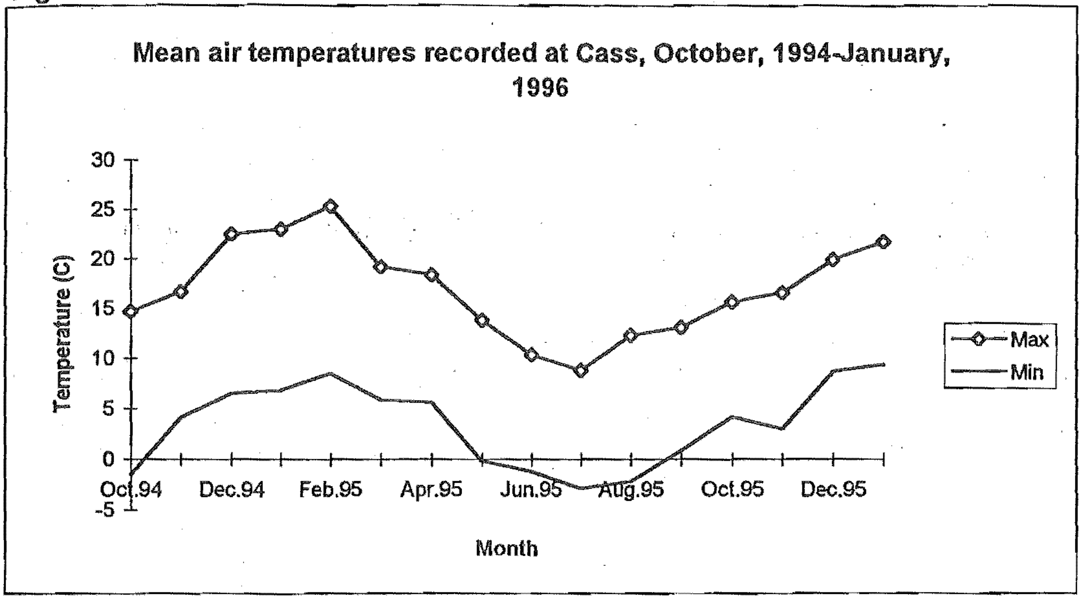


Figure 3.1

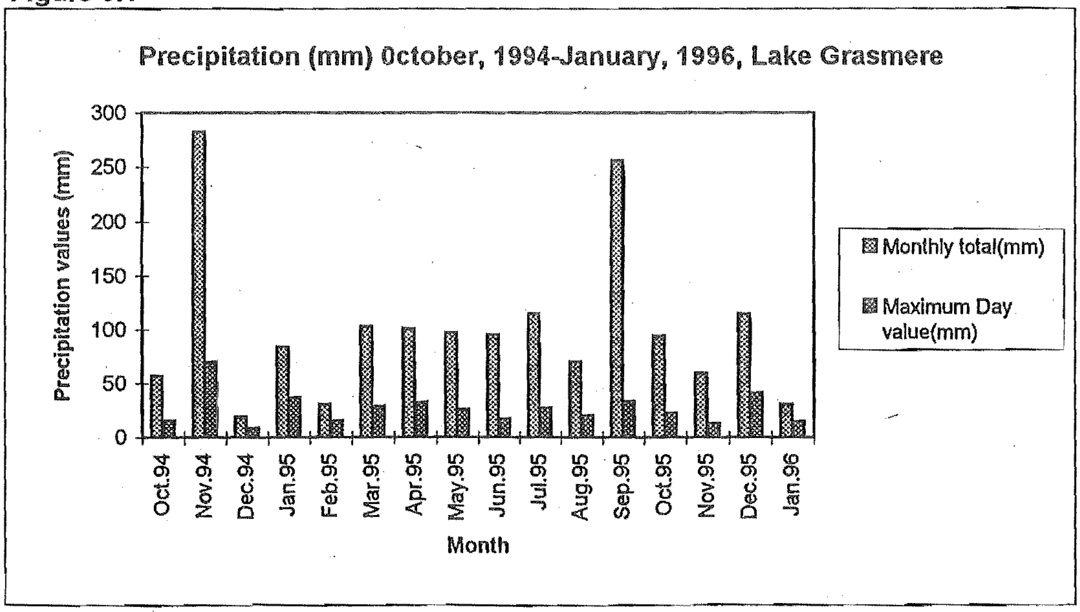


Plate 10: Ice patch on Lake Grasmere (August 1995).

Plate 11: Waterfowl and crested grebe clustered together in an ice-free section of Lake Grasmere.

precipitation can be up to 8000mm along the mountain tops and 600 mm in Christchurch (N.C.B.& R.W.B., 1986). Mean annual precipitation at Cass is 1276 mm, with maximum falls occurring in spring (Shanks et al., 1990). Precipitation data from a weather station on site at Lake Grasmere was obtained from Canterbury Regional Council. Monthly precipitation averages are shown in Fig 3.1.

Snow falls occur in the Cass basin in winter but remain only for a few days. Very heavy snowfalls and winters when frosts are also abnormally harsh may cause snow to persist in the basin for several weeks.

Strong winds are a characteristic feature of the Cass basin weather pattern. The prevailing wind blows from the northwest and can reach high velocities particularly along exposed ridges and in the basin itself (Greenland 1977, Shanks et al., 1990). These strong winds create intense wave action on high country lake surfaces (Plate 12). Lakes Pearson and Grasmere are shallow lakes by international standards. This, combined with the presence of strong winds, rarely results in thermal stratification for any length of time occurring within the lakes. Local winds occur, influenced by the basin topography. Anabatic winds flow up slope during the day as a result of valley heating. Katabatic winds flow down slope at night bringing cold air from the mountain tops into the valley basins. This process creates temperature inversions which result in the formation of thick fog and low cloud. These conditions occur during early morning and often fill the entire Cass basin. Morning bird counts sometimes had to be abandoned due to inability to see the birds as a result of thick fog (Plate 13). Inversions can occur 57% of the

Plate 12: Strong northwest wind creating intense wave energies on Lake Pearson.

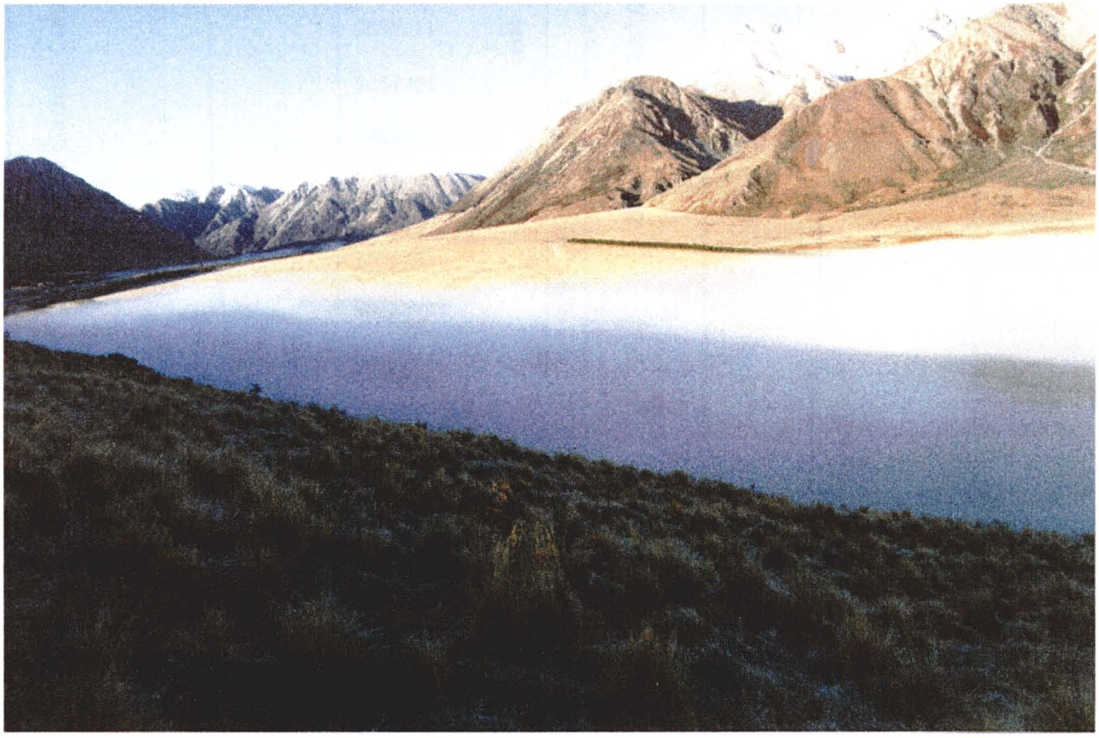


Plate 13: Fog blanketing Lake Grasmere.

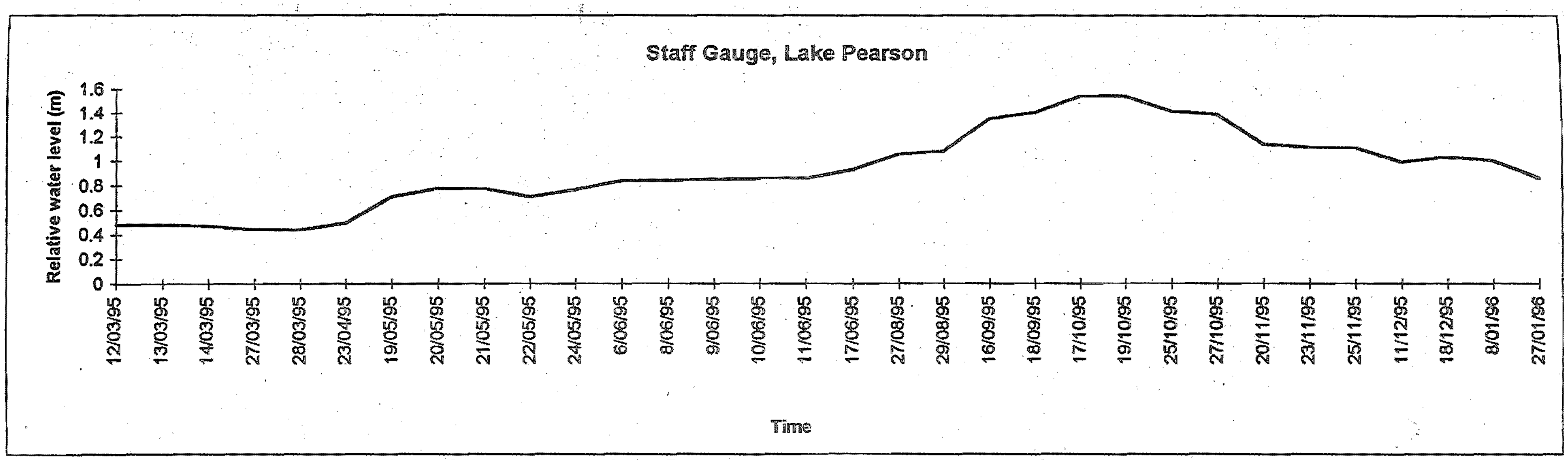


Figure 3.2: Relative water level, March 1995-January 1996, Lake Pearson

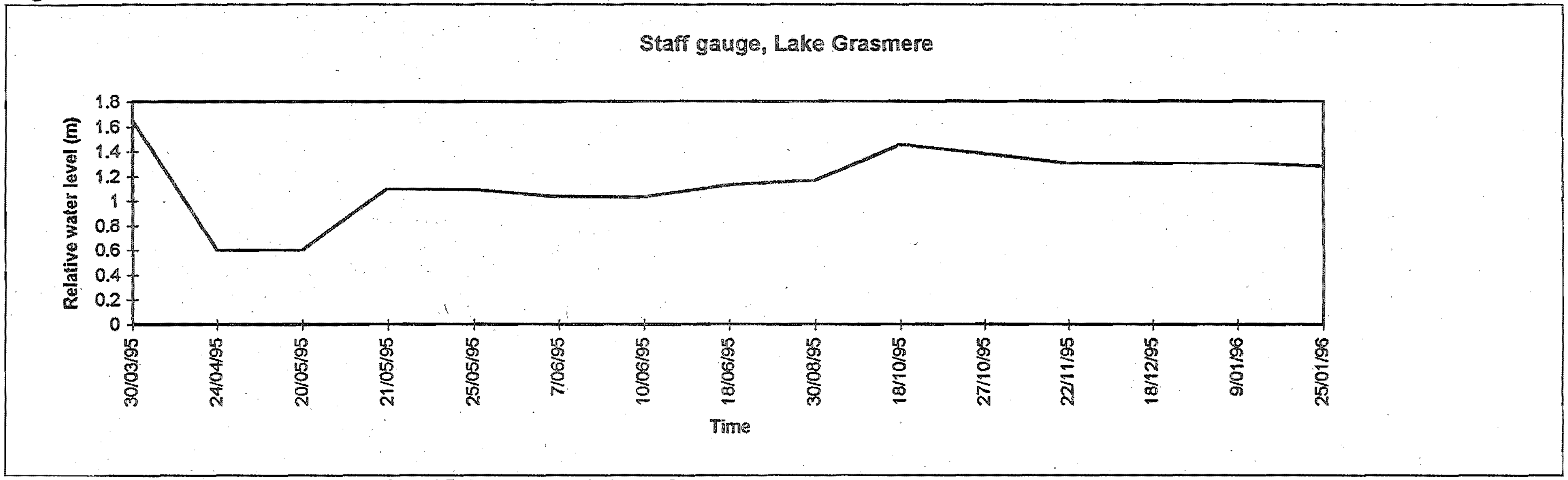


Figure 3.3: Relative water level, March 1995-January 1996, Lake Grasmere.

year in the Cass basin (Greenland 1977).

3.2 LAKE PEARSON

(3.2.1) Physical Characteristics

Lake Pearson is the largest of all the lakes in the upper Waimakariri catchment measuring 3.7 kilometres in length and 1.7 square kilometres. Maximum depth is 17 metres and the lake is situated 607 metres above sea level. Lake productivity has been classed between oligotrophic and mesotrophic (N.C.C.B. & R.W.B., 1986).

Lake Pearson was formed from the damming action of post glacial alluvial fans and to a lesser extent talus slopes and rock (Gage 1959, 1977). These fans are a distinctive feature of the landscape, with one fan descending from Purple Hill alongside Lake Pearson, dividing the lake into two separate basins (Fig.2.0, Plate 3).

Lake inflows include Craigieburn stream at the south end of the lake, and some seepage from Ribbonwood stream (Fig.2.0). Subsurface inflow through the permeable moraine gravels also occurs. Flow from this source increases during spring due to the seasonally heavier rainfall. Springs can be observed in action during this time along the southern shoreline. The Lake Pearson outlet is Winding Creek. Staff gauge measurements show a rise in lake level over winter, peaking during the increased precipitation at spring (Fig. 3.2).

Lake Pearson has a low, sloping shoreline containing predominantly gravel beaches (Plate 22). Component substrates vary from coarse to fine sediments; indicative of the wave energy received at a particular location.

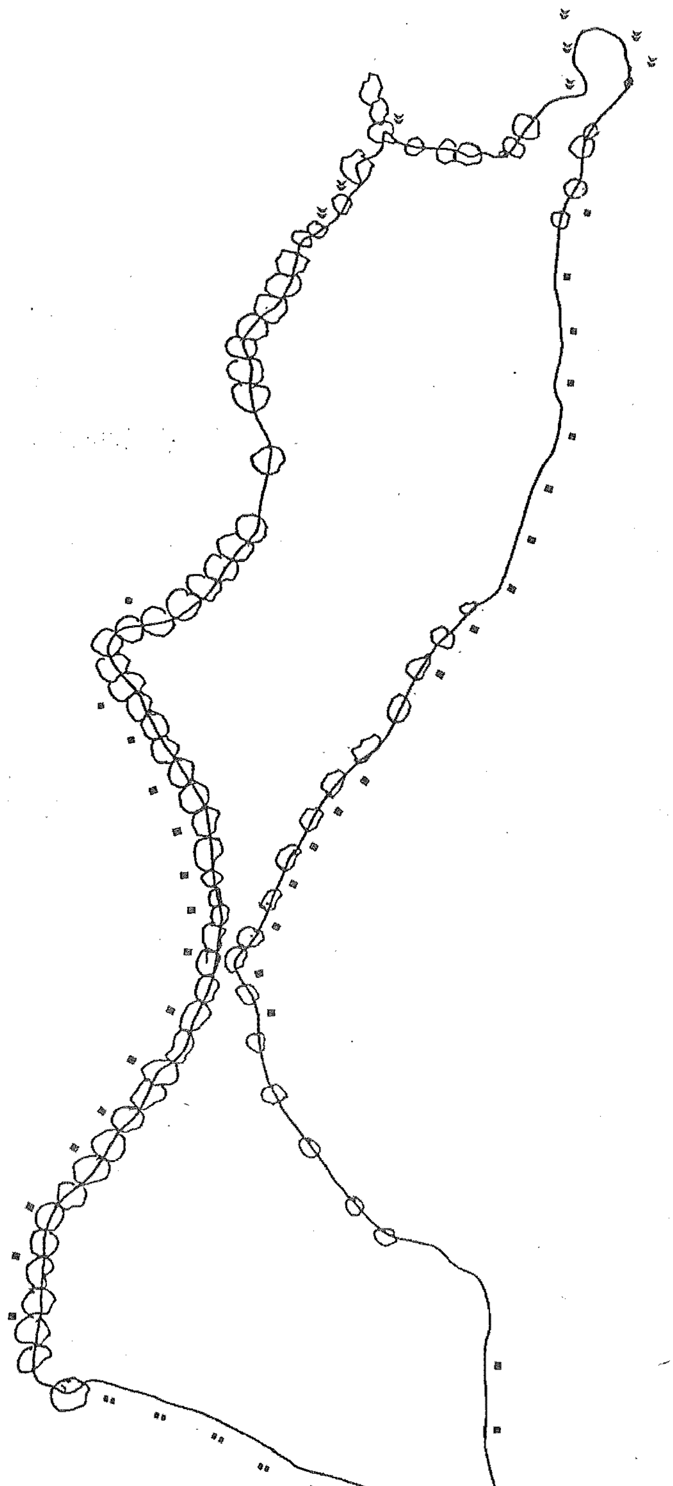
Bays along the northeast side are mainly shallow and are comprised of fine substrates. The eastern edge in contrast contains a beach structure comprising large cobbles and rocks as a result of bearing the brunt of waves generated by the northwest wind. Benthic substrates consist of cobbles and stones, sometimes mixed with finer sediments. Mud and silt are present in wetland regions.

Lake Pearson thus encompasses a variety of bird habitat types including a small wetland, mudflats, lagoons and open water.

(3.2.2) Terrestrial Vegetation

Crack willow (*Salix fragilis*) trees line the shoreline perimeter of Lake Pearson (Fig.3.4) apart from the southern end of the lake. They are dominant feature of the riparian vegetation. Other component species include matagouri (*Discaria toumatou*), *Coprosma propinqua, Rubus schmidelioides* and *Hebe venustula*. This shrubland contains a grassland understorey of fescue tussock including sweet vernal (*Anthoxanthum odoratum*) and brown top (*Agrostis tenuis*) (Shanks et al., 1990). This plant community mixture exists along the slopes of Purple Hill and the eastern edge of Lake Pearson. Sedgeland dominated by bog rush (*Schoenus pauciflorus*) extends from the wetland located at the northern end of the lake along the northeast margin. Damp riparian margins contain plant species such as *Juncus articulatus, Potentilla anserinoides, Hydrocotyle* and *Carex coriacea*

Figure 3.4: Riparian vegetation, Lake Pearson.



LAKE PEARSON VEGETATION KEY

Crack Willow trees ◯ Shrubland ▪

Pasture ▪▪ *Schoenus sedgeland* ¥

(3.2.3) Aquatic Vegetation. Extensive stands of raupo (*Typha orientalis*) exist in the wetland region. Other aquatic species include *Myriophyllum triphyllum* and *Potamogeton cheesemannii*, which are particularly dominant in this wetland region. The adventive weed *Elodea canadensis*, also known as Canadian pondweed, is present but not as common. *Pilularia novae-zelandiae* is found on fine mud substrates. This small fern has been stated as having indeterminate risk status (Given, 1989). *Isoetes alpinus* occurs in some locations in Lake Pearson, preferring coarse substrates. Aquatic vegetation does not grow on wind exposed sections of Lake Pearson.

3.3 LAKE GRASMERE

(3.3.1) Physical Characteristics

Lake Grasmere is smaller than Lake Pearson measuring 1.5 kilometres in length and 0.6 square kilometres in area. Maximum depth is 15 metres and the lake is situated at 583 metres above sea level. Lake Grasmere is classed as mesotrophic in trophic status, exhibiting a greater productivity level and nutrient loading than Lake Pearson (N.C.B.& R.W.B., 1986). Lake Grasmere was formed as a result of moraine damming along an ice worn ridge (Long Hill, Fig 2.0). The remaining perimeter of the lake has been enclosed by alluvial fans (Gage 1959).

Lake inflows occur predominantly in the form of benthic springs although a small stream exists in the south east corner of the lake (N.C.C.B. & R.W.B. 1986; Stout, 1977). Springs which are responsible for the bulk of the flow are formed as a result of water seepage through surrounding the flow are formed as a result of water seepage through surrounding catchment moraine gravels. As in Lake Pearson the springs of Lake Grasmere become increasingly obvious after a period of heavy rain. The outlet of Lake Grasmere is Grasmere stream which occurs at the northern end of the lake and flows into a nearby high country lake, Lake Sarah.

Staff gauge data from Lake Grasmere show a steady water level over winter rising sharply with the spring rains and levelling off during summer (Fig 3.3).

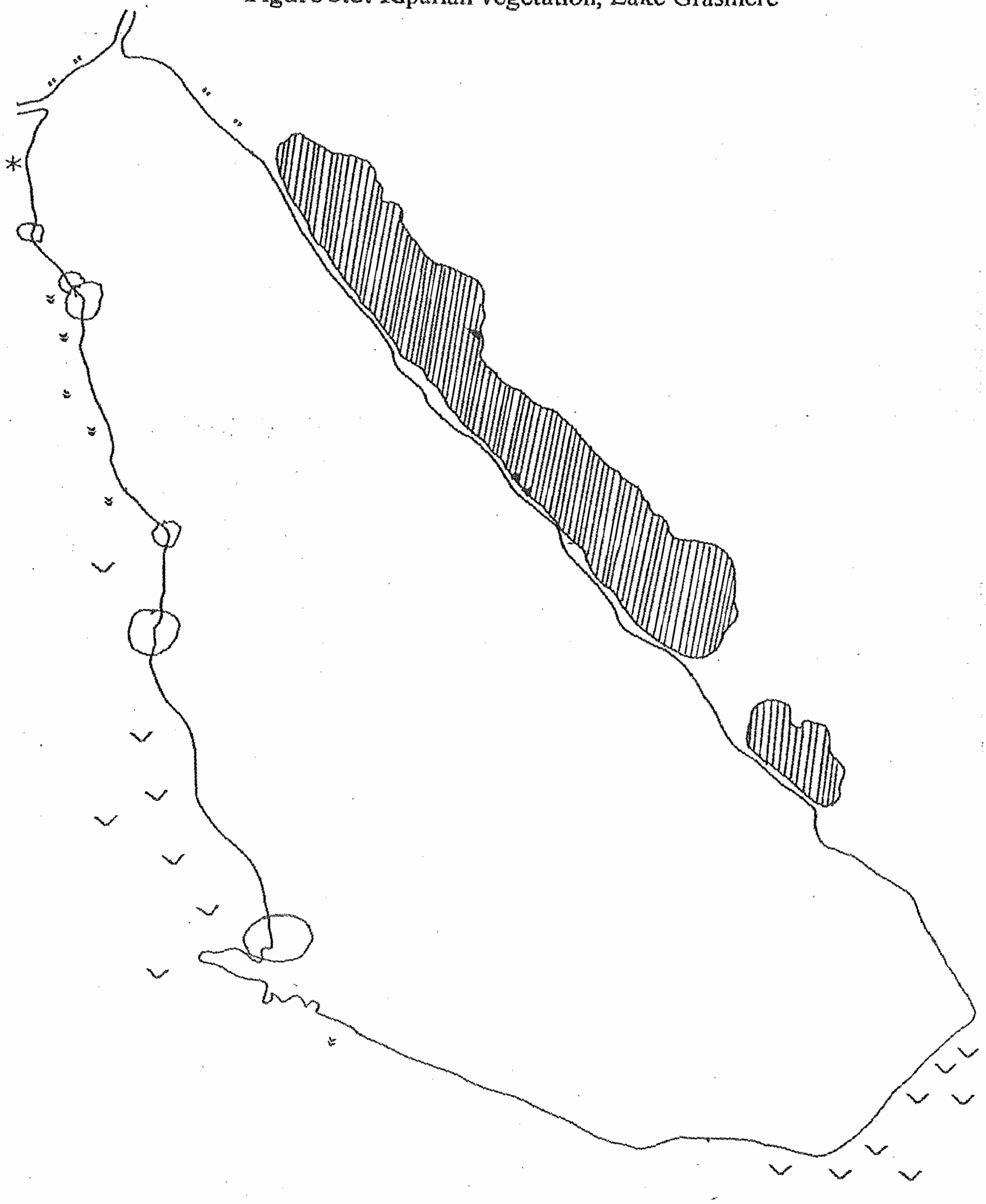
The shoreline of Lake Grasmere is characterised by steep, abrupt banks which become progressively more cliff like along the northeastern edge (Plate 27). The water at the edge is relatively deep compared with Lake Pearson. Gravel beach only occurs at the south and southeastern end of the lake where it also acts as a sediment bar, sheltering a lagoon and associated wetland behind it. The formation of this beach is a direct result of receiving intense wave action from the prevailing winds. Apart from this small section of beach and those locations which bear intense wave energies, the remaining shoreline consists predominantly of mud and silt substrates. The eastern shoreline in particular suffers in many places from bank slumping. The remains of previous banks are present along the eastern edge waters. The benthic substrate is comprised of a deep layer of mud with some gravel in various locations. Lake Grasmere has predominantly open water habitat that is of relatively uniform depth in many places. Lake Grasmere has a smaller number of habitat types for bird species compared with Pearson. However, Lake Grasmere has been classed as a wildlife refuge since 1957 with recreation reserve status overlain in 1970 (Shanks et al., 1990).

(3.3.2) Terrestrial Vegetation

A mountain beech (*Nothofagus solandri*) forest remnant exists along the eastern side of the lake extending down to the lake edge on Long Hill (Fig 3.5, Plate 27). This is classed as a scenic reserve and is fenced to protect it from grazing. The reserve also contains mingmingi (*Coprosma propinqua*), mountain wineberry (*Aristotelia fructicosa*), and koromiko (*Hebe salicifolia*) scrub along with brown top (*Agrostis tenuis*) grassland. Outside the scenic reserve, the remaining land is farmed and contains fescue tussockland as the dominant vegetation type. Patches of scrub occur containing matagouri (*Discaria toumatou*), *Coprosma propinqua, Rubus schmideliodes* and introduced species such as gorse (*Ulex europeaus*) and broom (*Cystisus scoparius*), (Shanks et al., 1990). In damp sites on Long Hill, isolated clumps of *Schoenus pauciflorus* sedge occur along with New Zealand flax (*Phormium tenax*). The remaining lake perimeter is surrounded by extensive swamp, and sedgeland. Directly behind these vegetation types exists farmland (both cultivated and non-cultivated). Swamp at the southernmost end is deep and extends from behind the lagoon to the base of Long Hill and grades into farmland. This swamp region contains species such as *Carex secta*, and *Schoenus pauciflorus*. Swamp of lesser depth occurs along the eastern side and contains the same species with *Schoenus pauciflorus* sedgeland becoming dominant towards the north of the lake. Pasture grass with *Carex coriacea* occurs in places at the north and south ends of the lake.

Extensive stands of New Zealand flax (*Phormium tenax*) occur along the

Figure 3.5: Riparian vegetation, Lake Grasmere



LAKE GRASMERE VEGETATION KEY

Beech forest

Crack willow trees

Schoenus pauciflorus sedgeland

Carex secta swamp

Pasture

Introduced Broom

north of the lake at the entrance of the outlet and throughout the length of Grasmere stream. *Carex secta* is also common. Isolated crack willow individuals occur irregularly along the eastern and southwest side of lake Grasmere but are somewhat smaller in size than the plentiful specimens present at Lake Pearson.

The shoreline of Lake Grasmere is therefore very exposed to the winds as it does not have continuous shoreline cover as Lake Pearson exhibits.

(3.3.3) Aquatic Vegetation

Lake Grasmere contains extensive beds of aquatic vegetation species. These cover much of the lake but diminish towards the southern end. The dominant species is *Elodea canadensis* which can be generally found in water less than one metre to seven to eight metres depth in lakes across New Zealand. *Pilularia novae-zelandiae* a tiny, native fern, is found in fine mud substrates in Lake Grasmere. *Isoetes alpinus* is also present in locations containing coarser substrates. Other aquatic plant species recorded from Lake Grasmere include *Ranunculus fluitans, Myriophyllum triphyllum* and *Potamogeton cheesemanni*. Charophytes (stoneworts) including *Chara* and *Nitella* species, exist in the lake (Stout, 1977).

3.4 LAKE SARAH

Lake Sarah is a small high country lake located in close proximity to Lake Grasmere (see Fig.1.0, Plate 15). Although it is not included in the main focus of this research, its presence is not totally ignored and it plays an

Plate 14: Lake Grasmere shoreline with steep banks, muddy benthic substrate in foreground.

Plate 15: Lake Sarah.

important role in providing bird habitat in the Waimakariri River valley.

Like Lakes Pearson and Grasmere, Lake Sarah was created from glacial processes, namely damming by ablation moraine and other glacial deposits at the foot of Mt Sugarloaf (Gage 1959).

Lake Sarah is located at 579 metres above sea level and measures 0.7 kilometres in length with an area of 0.2 square kilometres in area. Maximum depth is 6.7 metres (N.C.C.B.& R.W.B.,1986)

The major inflow into Lake Sarah is Grasmere stream which originates from Lake Grasmere. Lake Sarah drains into Remus swamp and eventually forms Grasmere stream again, which after flowing through a swamp system near Cass, terminates at the Cass River. Lake Sarah is surrounded by extensive raupo (*Typha orientalis*) swamp particularly towards the northeast. Flax and *Carex secta* are prominent species in this swamp. The swamp grades into *Schoenus pauciflorus* sedgeland followed by matagouri and tussock grassland along the Mt Sugarloaf edge. With similarities to Lake Grasmere, the shoreline of Lake Sarah is abrupt and steep with no beach formation.

The bird community of Lake Sarah is predominantly composed of a variety of waterfowl species. At least one pair of crested grebes utilise the lake at any one time. The extensive swamp surrounding much of the lake and downstream from it (Remus swamp) is considered to be of prime importance to the marsh crake (*Porzana pusilla affinis*). The swamp complex is also regularly used by shags, waterfowl, the Australasian Harrier Hawk (*Circus approximans*) and Pied stilts (*Himanotopus himanotopus* *leucocephalus*).

Land surrounding the lake but located behind the swamp system is under agricultural production. Merino sheep and Hereford cattle are stocked on this land at various times throughout the year, with the cattle in particular having access to the lake shore.

Lake Sarah is a popular location for anglers. The lake is very accessible to fishermen with a secondary road located along the southern edge. Camping facilities do not exist.

3.5 SITE DESCRIPTIONS

(3.5.1) Lake Pearson

Lake Pearson was divided up into five study sites (Fig 2.1, Plate 3). For derivation of sites see Chapter 2. In describing shoreline structure and component vegetation, I am concerned with the 20 metre wide strip as a designated part of each site (see Chapter 2, Methods section, for more information). Sites 1, 2, 3, and 4 are all components of one basin.

(3.5.1.1) Site 1

Site 1 (Plate 16, Fig 2.1) is located at the northern end of Lake Pearson and encompasses the major wetland region of the lake. The shoreline is largely dominated by mudflats of gentle slope. Water depth is very shallow, gradually increasing in depth towards the site 2 border (Fig 3.6a,b). A greater mudflat area is exposed during drought when lake levels drop. Benthic substrate is predominantly soft mud.

Plate 16: Site 1, Lake Pearson. Mudflat and raupo (*Typha orientalis*).

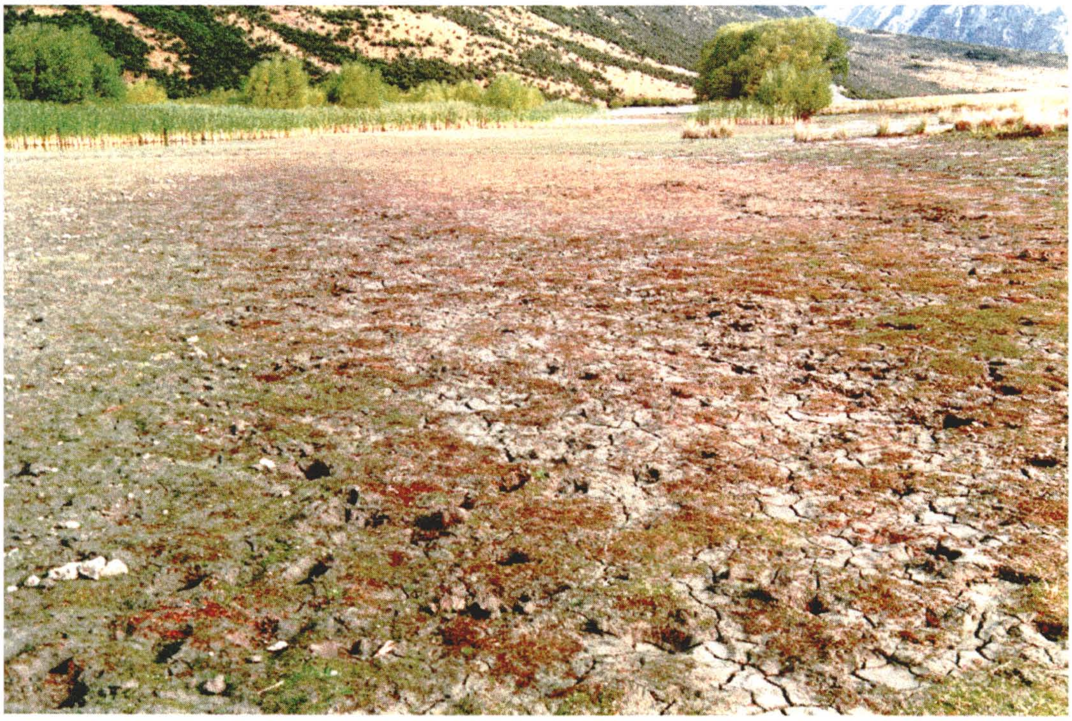


Plate 17: Trampling damage to mudflat by cattle, Site 1, Lake Pearson.

VEGETATION KEY FOR LAKE SHORE PROFILES

Isoetes alpinus	*Schoenus pauciflorus*
Charophytes	*Juncus articulatus*
Myriophyllum triphyllum	*Carex gaudichaudiana*
Pilularia novae-zelandiae	*Utricularia monanthos*
Potamogeton cheesemanii	Terrestrial weed
Elodea canadensis	Crack willow root growth

SUBSTRATE KEY FOR LAKE SHORE PROFILES

Mud/Sand	Fine Gravel (<60mm)
Cobble (30-60mm)	Cobble (60-250mm)

Figure 3.6 Vegetation and substrate key for lake shore profiles.

Figure 3.6a

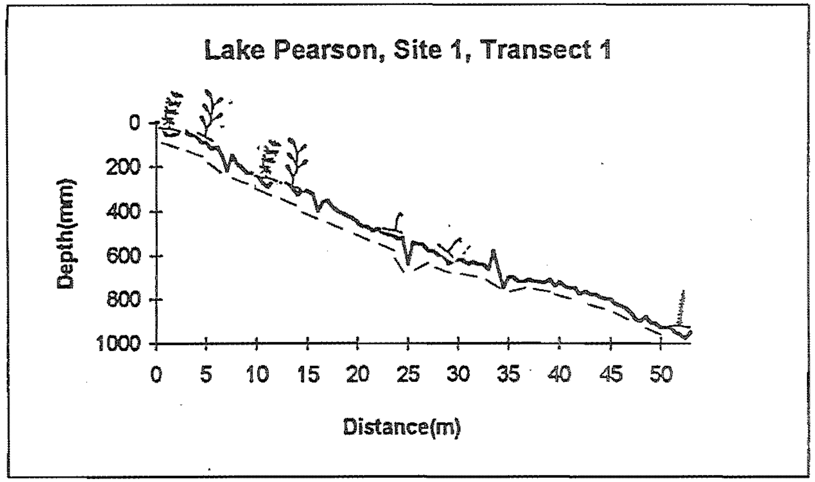
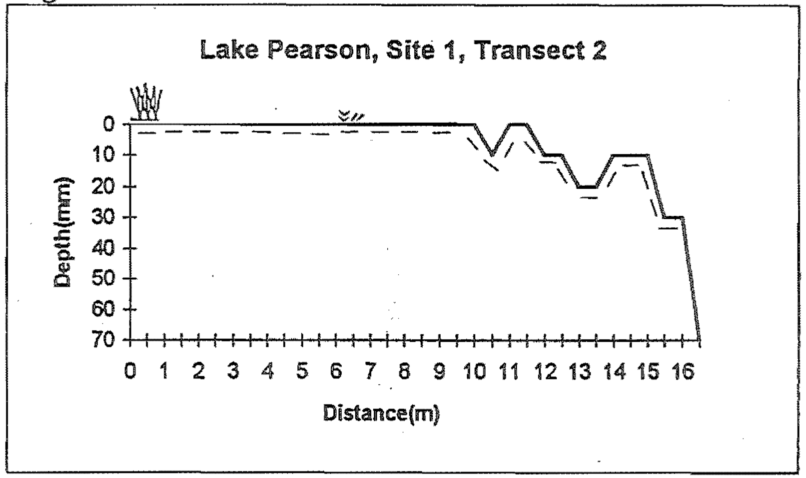


Figure 3.6b



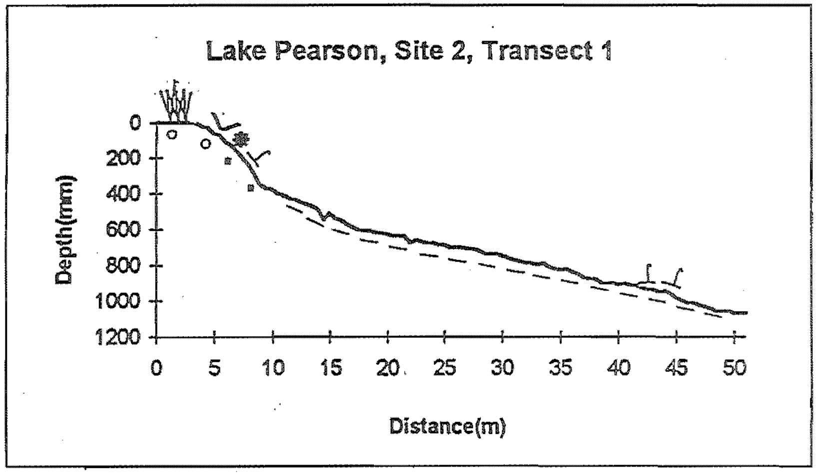


Figure 3.7a

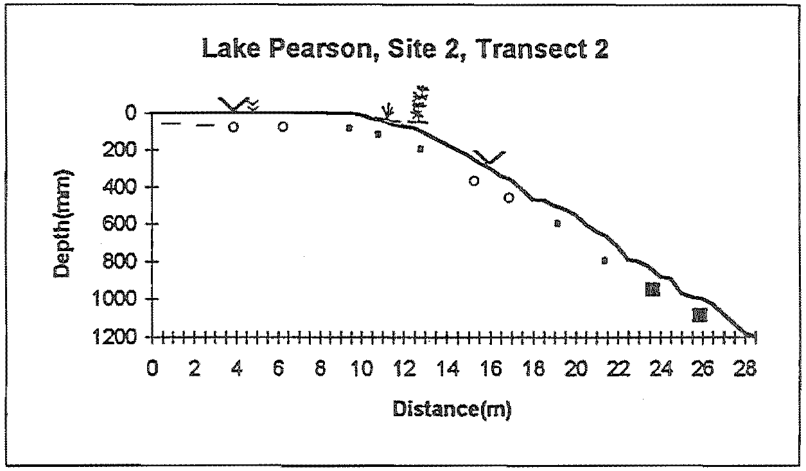


Figure 3.7b

Figure 3.6a-3.7b: Lake shore profiles for Lake Pearson, showing substrate and distribution of aquatic vegetation to depth and distance from shore. Note differences in scale between graphs.

The dominant vegetation species is raupo (*Typha orientalis*) whose stands extend from the lake edge into the main body of water in site one.

Isolated patches of *Juncus articulatus* are present on the mudflat and in damper regions, *Utricularia monanthos*. This mudflat grades into *Schoenus pauciflorus* sedgeland and tussock grassland with the former showing greater dominance in damp places. Amongst the sedgeland, species including *Potentilla anserinoides, Carex gaudichaudiana, Carex coriacea.* and *Schizelema cockaynei* were found.

Aquatic vegetation is prolific, with the dominant species being *Myriophyllum triphyllum*. Other species present include *Potamogeton cheesemanni, Elodea canadensis* and *Pilularia novae-zelandiae*.

Directly behind the sedgeland zone is grazed tussock grassland. This land is farmed by Craigieburn Station and stocked with Hereford cattle, and merino sheep. These animals have access to the lake edge where they venture to drink. I have witnessed on at least one occasion, a cow knee deep in mud, feeding on the aquatic vegetation. Much of the lake edge has suffered trampling and 'puddling' by cattle (Plate 17).

Site one is utilised by trout fishermen.

(3.5.1.2) <u>Site 2</u>

Site 2 (Figs 2.1, 3.7a, b, Plate 18) abuts sites 3 and 4. This site is used widely for recreation use.

It is characterised by a gently sloping shoreline composed of gravel beaches with large areas of shallow water (Fig3.7a,b). River fans exist on the northernmost edge of site 2 where the water is very shallow.

Plate 18: Site 2, Lake Pearson. Picnic area indicated by arrow.

Plate 19: Fishing cottage, Site 2, Lake Pearson.

Benthic substrates consist of silt in the sheltered locations, and gravel and pebbles where it is more exposed. Larger cobbles and rocks occur in deeper water.

Schoenus pauciflorus sedgeland occurs along the length of the shoreline from the site one border, interspersed with pasture grass, ceasing at the picnic area. Directly behind the sedgeland, the vegetation cover changes to matagouri and *Coprosma propinqua* scrub and grassland. Other shrubs present include *Rubus schmideliodes* and *Hebe venustula*.

Willow trees line the shoreline throughout the site becoming more abundant towards the south. These overhang the water edge and provide continuous cover for bird species.

The northern area of site 2 abuts a large paddock which is grazed periodically by Hereford cattle and merino sheep. These animals have access to the lake edge where they venture to drink.

Aquatic vegetation consists of *Pilularia novae-zelandiae* in muddy substrates. *Isoetes alpinus* is less common and was only found sparingly amongst gravels.

The Lake Pearson staff gauge is located in this site.

Site 2 is a very popular spot for anglers. Two permanent fishing cottages are present along the site 2 perimeter (Plate 19). The picnic area provides toilet and camping facilities. This site is a popular swimming spot for families with young children due to the shallow nature of the bays.

(3.5.1.3) Site 3

Site 3 (Figs.2.1, 3.8a, b, Plate 20) has similarities to site 2 in shoreline structure and component vegetation. The bulk of site 3 is taken up by a large sheltered bay known as Ritchies Bay. Site 3 is lined with large willow trees behind which a matagouri, *Coprosma propinqua* scrubland is present. Gravel beaches continue throughout this site. Benthic substrates are fine in the shallows graduating out to large rocks in deeper water. Excluding Ritchies Bay, benthic and beach sediments are slightly coarser than those in site 2. At the southern part of site 3 where the lake narrows to a "gap", large boulders are present in deep water.

Myriophyllum triphyllum beds exist in water more than two metres deep.

(3.5.1.4) <u>Site 4</u>

Site 4 (Figs.2.1, 3.9a, b, Plate 21,) encompasses the eastern side of the lake. It is bordered by Purple Hill and sites 2 and 3. Steep banks exist along Purple Hill. This site is very exposed to the prevailing north west wind. The shoreline is steep (Fig.3.9a,b) and beach sediments are of a coarser grade; indicative of the wave energies experienced by this site. Aquatic vegetation is absent along site 4 due to the prevailing strong winds. The prevailing water current can be easily observed in this site, particularly at the "gap". Lake shore vegetation consists of crack willow trees scattered along the shoreline but not abundant enough to exhibit continuous cover as can be seen at other sites. Matagouri and grazed tussock grassland exist on the flanks of Purple Hill.

Plate 20: Site 3, Lake Pearson.

Plate 21: Site 4, Coarse beach substrates, Lake Pearson.

Figure 3.8a

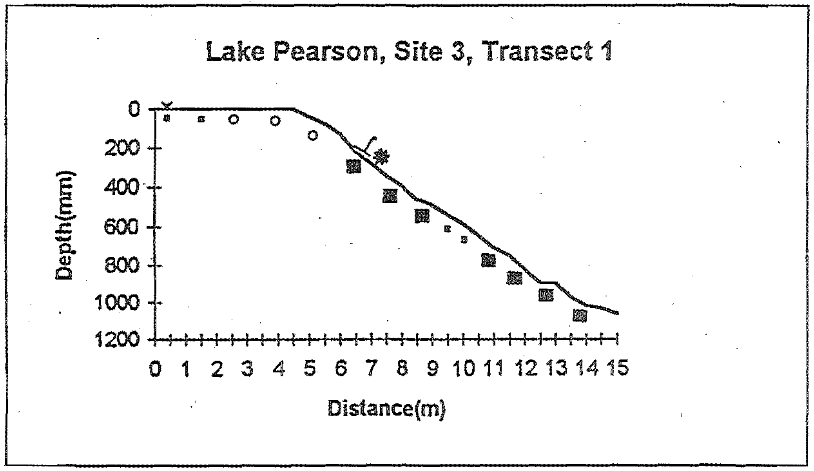
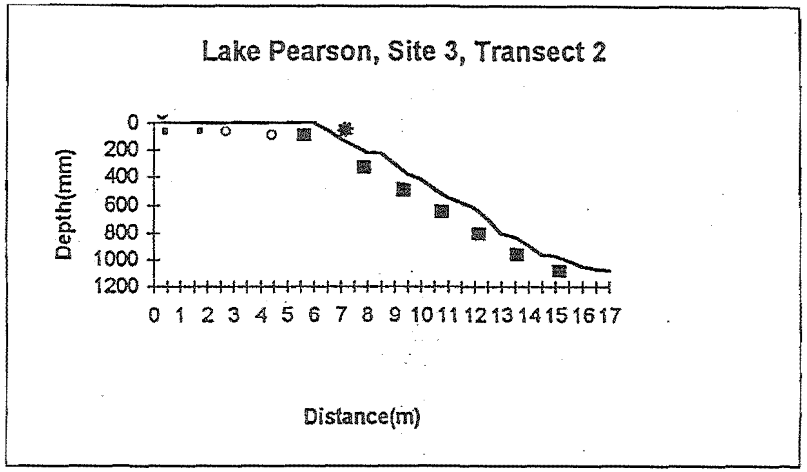


Figure 3.8b



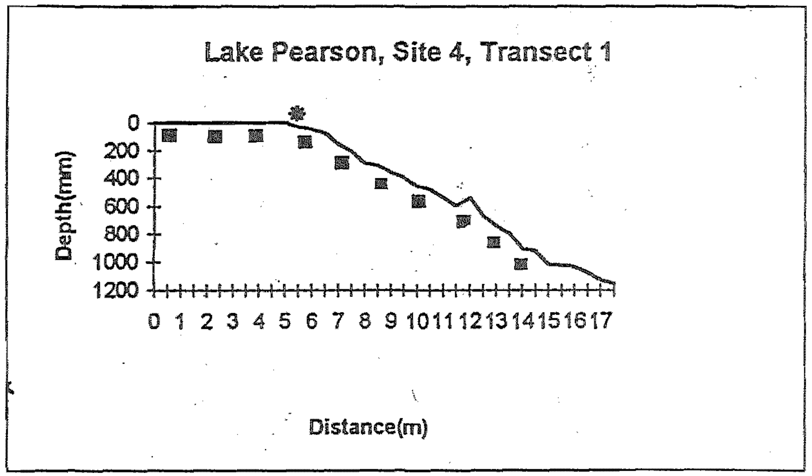


Figure 3.9a

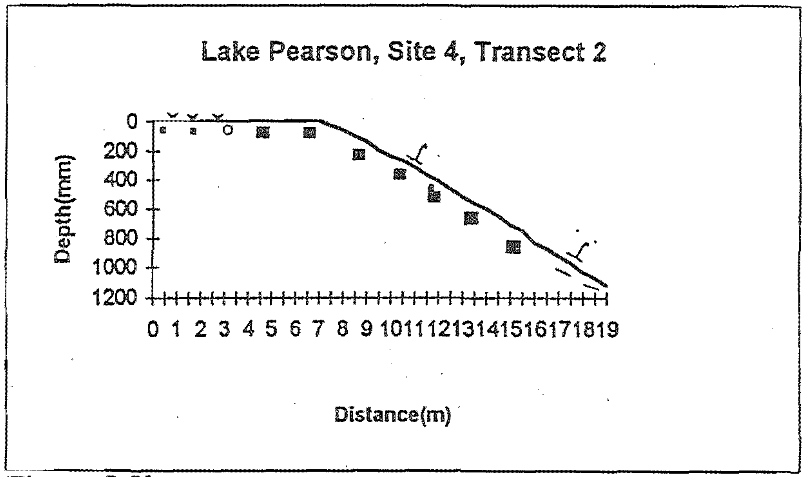


Figure 3.9b

Figure 3.8a-3.9b: Lake shore profiles for Lake Pearson , showing substrate and distribution of aquatic vegetation to depth and distance from shore.

(3.5.1.5) Site 5

This is the largest site and encompasses the southern lake basin of Lake Pearson (Figs.2.1, 3.10a,b, Plate 22,23). The most southern edge is abutted by farmland belonging to Flock Hill Station. The morainic fan descending from Purple Hill surrounds the northern and eastern edges. The fan contains a vegetation community consisting of matagouri and *Coprosma propinqua* shrubland and fescue tussock grassland. Crack willows are scattered along this northern edge but again do not form a continuous band of riparian cover. An isolated beech forest (*Nothofagus solandri*) remnant is present on the slopes of Purple Hill in the south east corner of site 5.

Vegetation surrounding the western edge is dense and crack willows form a continuous band of riparian cover along the shoreline.

This site has a continuous beach profile along the shoreline. These profiles are wide and in some places steep indicating high wave energies are experienced (Fig.3.10b). North west wind generated waves are funnelled through the narrow "gap" separating the two basins between sites 3, 4, and 5. An almost continuous water current runs from north to south of the lake. This current spills out in to the second basin (site 5) and with the prevailing winds, wave energies are intensified until becoming dissipated along the shoreline. Water leaves Lake Pearson via the outlet Winding Creek.

During times of high water levels, erosion of the shoreline and encroachment into existing farmland may occur, particularly during periods of intense storms. Shoreline gravels vary in size and grade depending on the wave energy intensity received at a given point at the site. Beach substrate

Plate 22: Site 5, Lake Pearson, looking towards the "gap" with Purple Hill fan to the right.

Plate 23: Site 5, Lake Pearson. Gravel beach shoreline. Purple Hill fan is in the background and Flock Hill Station to the right.

Figure 3.10a

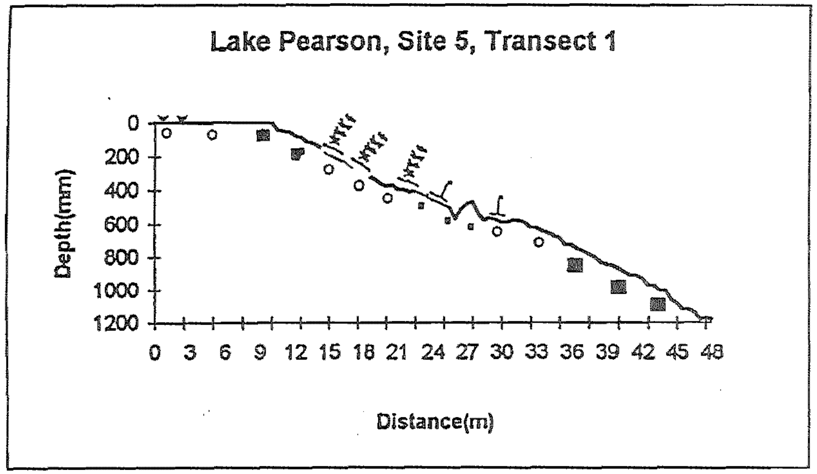


Figure 3.10b

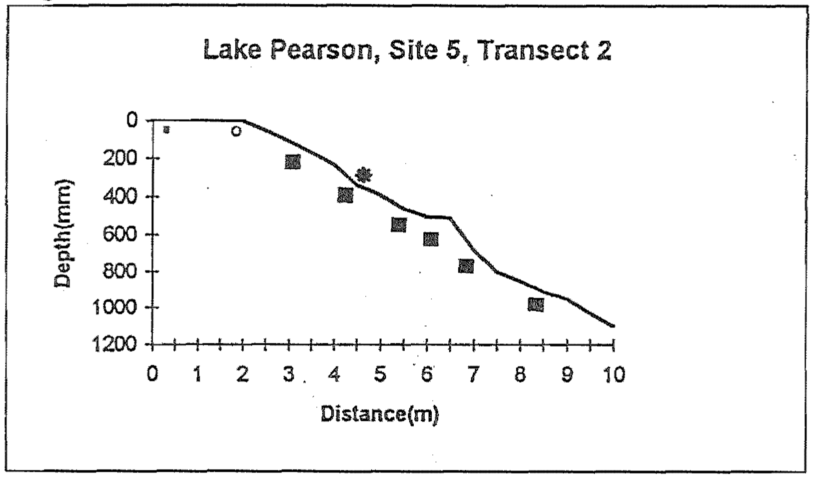


Figure 3.10a-3.10b: Lake shore profiles for Lake Pearson showing substrate and distribution of aquatic vegetation to depth and distance from shore. Note differences in scale between graphs.

along Purple Hill and associated fan are large and cobble in nature. Substrates are a mixture of fine and coarse along the southern shoreline.

State highway 73 is present along the western edge of Lake Pearson, so noise levels from road traffic are elevated considerably. This site is popular for fishing activities with anglers.

(3.5.2) Lake Grasmere

Lake Grasmere was also divided up into five study sites (Fig.2.2, Plate 4). As in Lake Pearson, the shoreline structure and component vegetation is described with the 20 metre wide strip, incorporated into each site.

(3.5.2.1) Site 1

Site 1 (Fig.2.2, Plate 24) is located at the northwest end of the lake. It is bordered by swamp, farmland, the lake outlet and open water. The shoreline is steep and abrupt compared to that of Lake Pearson. Shoreline structure is typically undercut clay banks with swamp vegetation overhanging water (Fig.3.11a,b, Plate 14). A small inlet is present along the northwest side of site 1. The outlet of Lake Grasmere is situated at the northwest end of the lake. A vegetation community dominated by New Zealand flax (*Phormium tenax*) but including *Carex secta* and *Coprosma propinqua* occurs from the lake side of the outlet, throughout much of the length of Grasmere stream. The steep clay banks are particularly noticeable along the northeastern edge beyond the outlet and are covered with a vegetation mixture of periodically grazed tussock grassland with matagouri and introduced broom. The northwestern edge of the site holds an isolated patch of introduced broom

Plate 24: Site 1, Lake Grasmere. Grasmere Station in the background.

Plate 25: Bank slumping, Site 1, Lake Grasmere.

Figure 3.11a

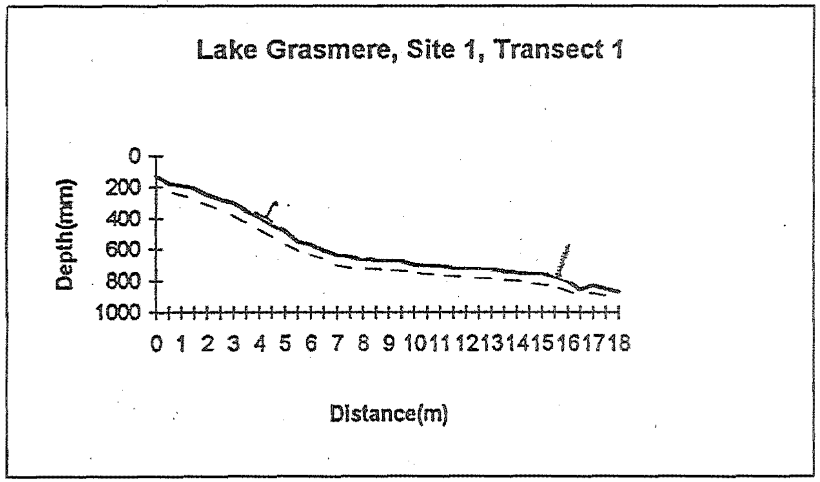
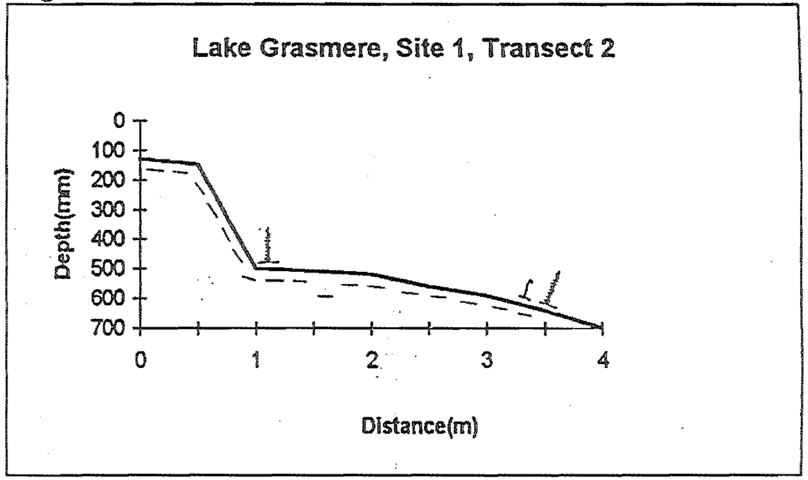


Figure 3.11b



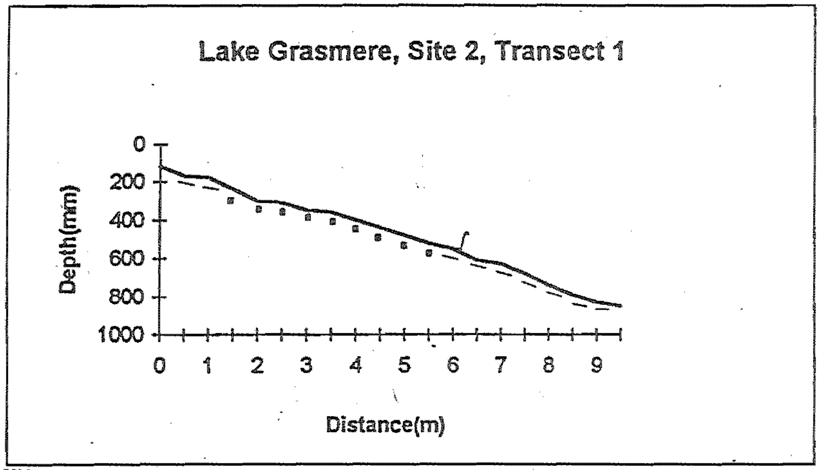


Figure 3.12a

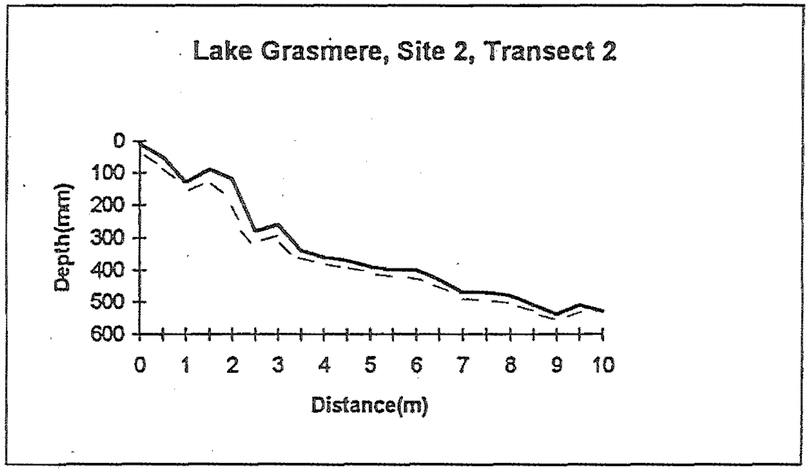


Figure 3.12b

Figure 3.11a-3.12b: Lake shore profiles for Lake Grasmere showing substrate and distribution of aquatic vegetation to depth and distance from shore. Note differences in scale between graphs.

amongst some grassland containing rautahi (*Carex coriacea*). This quickly grades into *Schoenus pauciflorus* sedgeland. *Carex secta* is present along the margin of the small inlet.

The benthic substrate of site 1 consists of soft mud. Pebbles do occur in patches close to the western edge and further out in the main body of the lake.

Aquatic vegetation is dominated by *Elodea canadensis* with *Pilularia novaezelandiae* also present.

Land under intense agricultural production belonging to Grasmere Station immediately surrounds the wetland complex along the northeastern side. One paddock is immediately adjacent to the northern end of the lake and stock have access to the lake edge. The pugging of low lying land along the waters edge can be attributed to cattle trampling which also plays a part in bank slumping. This is particularly noticeable in this site (Plate 25). An old unused boat shed is present in the inlet. Anglers fish along the shores of site 1.

(3.5.2.2) <u>Site 2</u>

Site 2 (Fig.2.2, Plate 4) abuts site 1, 3 and 5. The northwest edge is bordered by *Schoenus pauciflorus* sedgeland. *Carex secta*, and on the drier spots *Carex coriacea* are present. A band of introduced broom exists along a fenceline. Isolated crack willow trees are present at the border between sites 2 and 3 with one individual along the site 2 lake edge. Grasmere Station is immediately adjacent to the sedgeland. The two shore profile transects (Fig 3.12a, b) show a shoreline that steadily increases depth with distance. Transect 2 has a steeper profile that transect 1 for site 2. The remains of collapsed banks were found within two metres from the current lake bank along one transect (Fig.3.12b). Transects for this site hada shorter length due to the difficulty wading in soft mud which was the dominant benthic substrate. Silt, sand and pea gravel occurred in the first two metres of the first transect.

Aquatic vegetation consists of *Pilularia novaezelandiae*. *Elodea canadensis* exists in deeper water which was out of my sampling range. This site is fenced off from cattle and sheep, however they have been known to enter the sedgeland when farm gates have been left open.

(3.5.2.3) Site 3

Site 3 (Figs. 2.2, 3.13, Plate 26,) abuts sites 2, 4 and 5 and is situated at the southwest corner of the lake. It has similar physical characteristics to sites 1 and 2.

A group of established crack willow trees is present at the conjunction of sites 2 and 3 on the lake margin. The southwest lake edge is bordered by *Schoenus pauciflorus* sedgeland which contains an increased amount of *Carex secta*. This sedgeland appears to be a lot more waterlogged and "boggy" than the previous two sites. The raised water table is possibly due to the presence of a small creek that flows across Grasmere Station into Lake Grasmere. An inlet is present in the far southwest corner of Lake Grasmere. New Zealand flax exists along the edges of the inlet. The lake profile of site 3 is steep and contains the remains of collapsed banks creating the jagged appearance of the graph in Fig.3.13. The benthic substrate of site 3 consists

Plate 26: Site 3, Lake Grasmere.

Figure 3.13

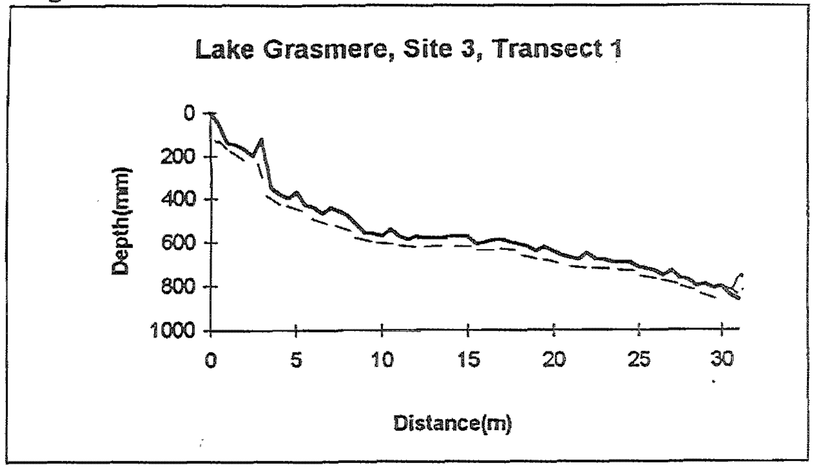
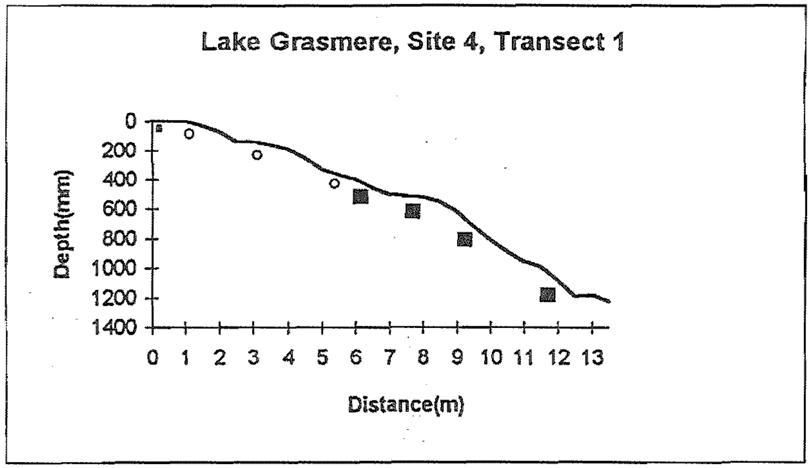


Figure 3.14a



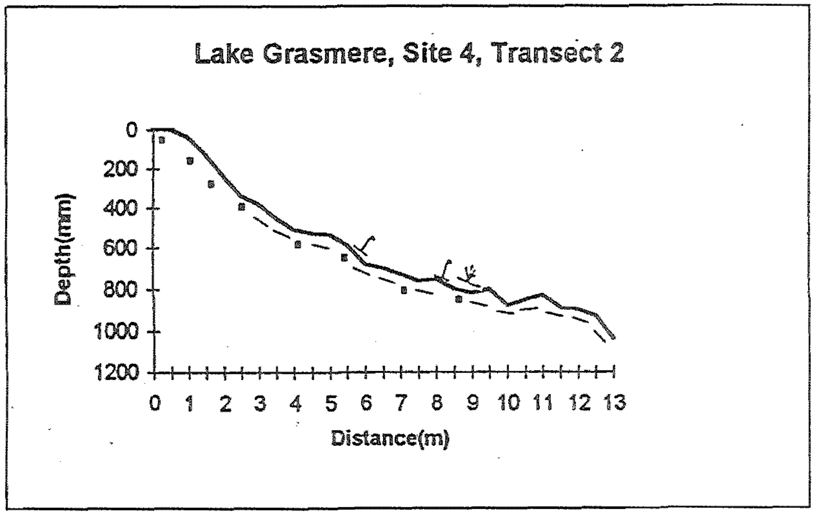


Figure 3.14b

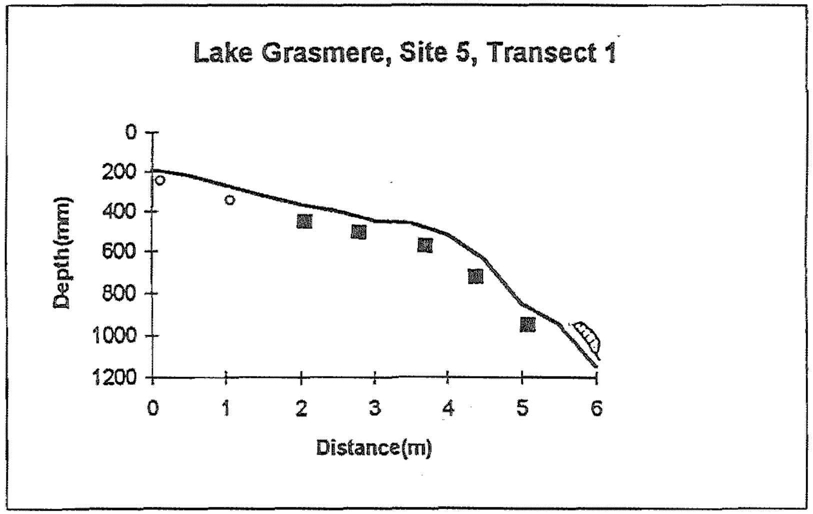


Figure 3.15a

Figure 3.13-3.15a: Lake shore profiles for Lake Grasmere, showing substrate and distribution of aquatic vegetation to depth and distance from shore. Note differences in scale between graphs.

of very soft mud. Undercut banks like those present in site 1 and in parts of site 2, do not exist in site 3. Regions of 'mud deltas' occur instead and these are popular places for waterfowl to roost on. The 'mud deltas' increase in area with low lake levels.

Aquatic vegetation consisted of *Pilularia novae-zelandiae*. *Elodea canadensis* beds exist further out in the main lake body. This site may be visited by cattle if gates are left open. Anglers sometimes fish along the lake edge.

(3.5.2.4). Site 4.

Site 4 (Figs.2.2, 3.14a, b, Plate 4) incorporates the southern end of the lake. It is abutted by sites 3 and 5.

Site 4 bears the brunt of wave energies generated by strong northwest winds, which are funnelled down the lake. The shoreline of site 4 is remarkably different from the other sites with gravel beaches. Shoreline slope was very steep in transect 1 (Fig.3.14a) which was not sheltered from the prevailing wind. The second transect which received some shelter from Long Hill, did not have such a steep slope.

The lake margin of site 4 encompassed patches of *Schoenus pauciflorus*, grazed pasture, and extensive swamp in the southwest corner of the lake. The swamp which is deeper than that present on the northwest side of Lake Grasmere contains *Schoenus pauciflorus* and *Carex secta*.

Cattle and sheep grazing on Ribbonwood fan (Craigieburn Station) have access to the lake margin of site 4. Consequently the margin receives trampling damage when stock venture to the lake edge to drink. Cattle often walk through the swamp located at the southeast end.

Benthic substrate is composed of pebbles and cobbles on the most exposed locations. Patches of silt and finer substrates were found in the second transect. This location received some shelter from wind from Long Hill. Collapsed bank material was present in water of 340 mm depth (Fig.3.14). A gravel beach also acts as a bar and separates site 4 and a lagoon. This lagoon grades into deep *Carex secta* and *Schoenus pauciflorus* swamp.

A picnic and camping area is located along the southern edge of site 4. Picnicking and to a lesser extent camping occurs here. Toilet facilities are available.

Site 4 receives the greatest disturbance from people. It is particularly common with anglers who fish along the lake edge. Site 4 contains the greatest water depths of Lake Grasmere.

(3.5.2.5) Site 5

Site 5 (Fig.3.15a, b, Plate 27) shows some differences with regards to its physical structure and vegetation communities.

It is located alongside the steep slopes of Long Hill. A mountain beech (*Nothofagus solandri*) forest remnant is present on Long Hill and extends to the waters edge. Other species present in the forest include *Coprosma propinqua* (korokio), *Aristotelia fructicosa* and *Agrostis tenuis* (brown top) (Shanks et al., 1990). The forest remnant is classed as a scenic reserve (Shanks et al., 1990). The forest remnant is fenced off from stock. Animals therefore do not venture into the remnant unless there is a gap in the fence.

Plate 27: Site 5, Lake Grasmere, mountain beech forest with steep sided banks. Frozen lake surface visible.

Due to the steep slopes it is impossible for animals to drink at the waters edge.

Steep, undercut banks line the lake edge throughout the site. Bank height is large with 900 mm recorded from bottom of bank to top in one transect.

Benthic substrates are coarse with pebbles and cobbles. Large boulders are present on the lake bed that have most likely originated from the slopes of Long Hill.

Aquatic vegetation is sparse but species collected included Charophytes, (*Nitella spp.*), which dominated the site, *Elodea canadensis*, *Pilularia novaezelandiae* and *Isoetes alpinus*. Site 5 is shaded and is also exposed to the prevailing winds.

Disturbance from human recreation activities is very limited, as there is no direct route of access into the site available to the public.

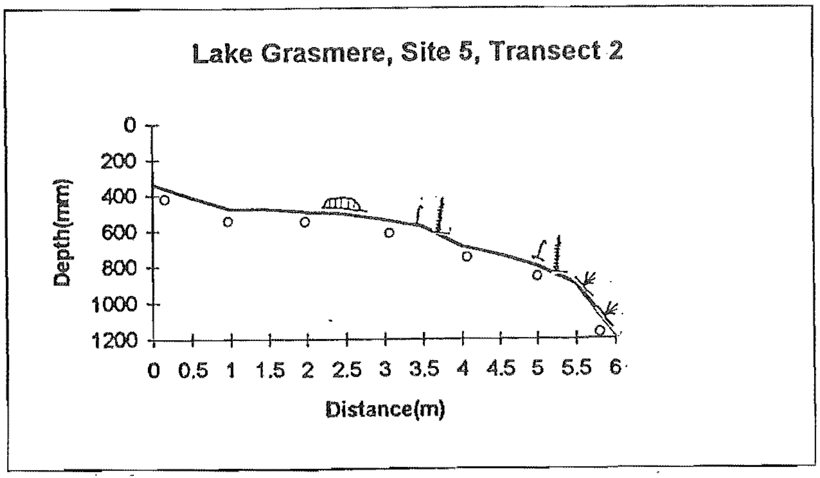


Figure 3.15b: Lake shore profile for Lake Grasmere, showing substrate and distribution of aquatic vegetation to depth and distance from shore.

CHAPTER FOUR

ORNITHOLOGICAL BACKGROUND

4.1 BACKGROUND INFORMATION FOR BIRD SPECIES

(4.1.1) Canada Goose (*Branta canadensis*)

Canada Geese (Plate 28a) were successfully introduced into New Zealand in 1905 (Marchant et al, 1990, Moon, 1992), possibly for sport (Long, 1981). Recent estimates for the Canada Goose population in New Zealand are 35-40 000. The South Island alone accounts for 32 000 birds distributed in central inland areas (Marchant et al, 1990).

Canada Geese predominantly feed on terrestrial vegetation, particularly pasture grasses and crops. Geese will also feed on aquatic vegetation if available (Potts & Andrew, 1991).

Birds breed within the headwater river valleys east of the Southern Alps between September and January. Clutch size can vary from 2 and 10 eggs. When young are fledged, geese migrate to lakes and tarns of lower altitudes or to the coast where they spend the winter in large congregations (Marchant et al, 1990, Potts & Andrew, 1991). Although the majority of Canada Geese breed in the river valleys, during the present study three pairs produced young at Lake Pearson in site 1. Three broods totalling seven chicks were raised. No breeding occurred on Lake Grasmere.

In recent decades, the development of crops and sown pastures within the

a)

b)

Plate 28: Canada Geese, **a)** Site 1, Lake Grasmere, **b)** feeding on pasture, Lake Grasmere Station.

South Island high country has led to large flocks of Canada Geese spending the winter upon high country lakes and tarns (Potts & Andrew, 1991). Geese feed on crops and pasture surrounding these lakes and tarns and foul the paddocks to such an extent that sheep may refuse to eat grass within the contaminated paddock (White, 1986).

Canada Geese flocks were considered to be a major pest on Grasmere Station. It was observed that geese would typically feed on pasture within the paddocks adjoining Lake Grasmere, followed by a period of loafing and feeding on the aquatic weed in the lake itself. Canada Geese rendered 80 hectares of farmland useless on Grasmere Station during 1995 as a result of crop damage and fouling (E. Chapman, Grasmere Station, pers.comm). Large geese flocks can therefore cause extensive economic damage to high country farms.

Attempts to control Canada Geese on Lake Grasmere have taken the form of culls. These are carried out by North Canterbury Fish & Game Council on Grasmere Station. Shooting is not allowed on the lake due to its wildlife refuge status. 140 geese were shot in a cull in August, 1995 on Grasmere Station (North Canterbury Fish & Game Council, pers.comm). Canada Geese were not such a problem on farmland aligning Lake Pearson, where they occurred in smaller numbers.

(4.1.2) Black Swan (*Cygnus atratus*)

The Black Swan (Plate 29) was introduced into New Zealand from Australia in 1864 (Long, 1981). A recent estimate for the Black Swan

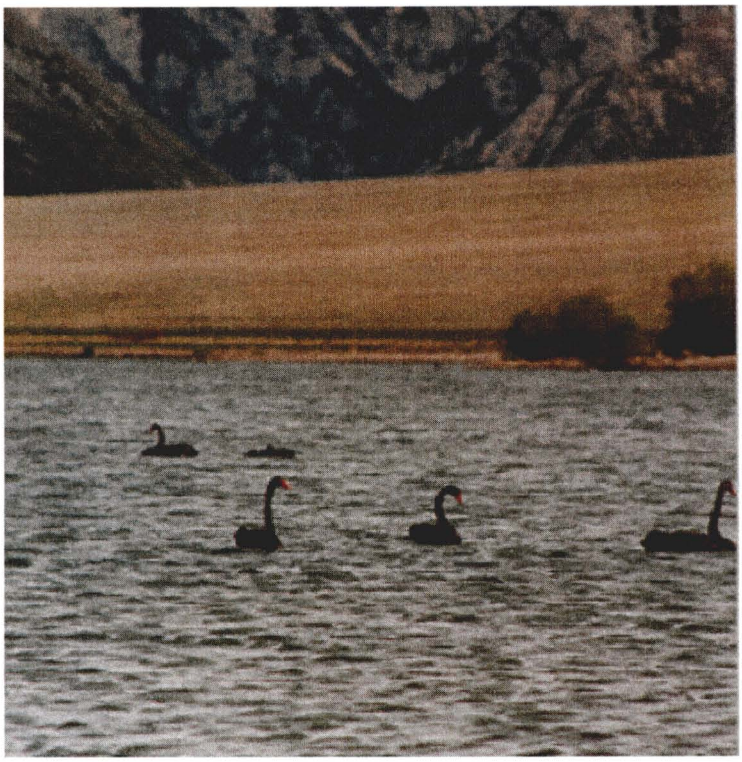


Plate 29: Black Swans, Site 1, Lake Grasmere.

Plate 30: Scaup, Site 4, Lake Pearson.

population in New Zealand is 60,000 (Marchant & Higgins, 1993). Black Swans are widespread throughout New Zealand located predominantly in coastal and lowland regions on large waterbodies (Marchant & Higgins, 1993). The Black Swan population in New Zealand has decreased during the last few decades. Huge colonies of 40,000-80,000 Black Swans existed in the past on Lake Ellesmere located along the Canterbury coast, south of Banks Peninsula. The "Wahine" storm of 1968 destroyed extensive aquatic weed beds in the lake, which subsequently had a detrimental affect on Black Swan population numbers from which the species still has not recovered (Marchant & Higgins, 1990, McKinnon & Mitchell, 1994).

Black Swans are herbivorous, feeding predominantly upon aquatic vegetation but will also eat terrestrial plants such as pasture species.

Black Swans were most abundant at Lake Grasmere, particularly in sites 1, 2 and 3. At Lake Pearson, Black Swans occurred for the majority of the time in site 1 but were observed on some occasions at sites 2 and 3.

Breeding occurs either in colonies or as isolated pairs between July and October (Marchant & Higgins, 1993). Reduced colonies still exist on Lake Ellesmere and some swans do return to the lake each year to breed. Clutch size is on average 4 and 5 eggs, and cygnets are nidifugous and can swim soon after hatching. After moulting, swans may congregate on inland lakes during the winter.

Three broods totalling eleven juveniles were produced by three pairs on Lake Grasmere. Nests were built in the New Zealand flax (*Phormium tenax*) and *Carex secta* swamp present within site 1 and Grasmere stream, or within

Schoenus pauciflorus sedgeland adjacent to site 2. Pairs with juveniles kept themselves and their young apart from the main flock of swans. No breeding occurred on Lake Pearson.

(4.1.3) Scaup (*Aythya novaeseelandiae*)

New Zealand Scaup (Plate 30) is endemic to New Zealand and a totally protected species. It is the only diving duck in New Zealand belonging to the same genus as the Pochards in North America.

The national population of Scaup is estimated to be between 5000 and 10 000 birds. Scaup are scattered throughout the North and South Islands from lowland to alpine regions on large, open, freshwater lakes of high clarity (Marchant & Higgins, 1993, Neilson, 1987). They are not found on brackish, coastal lakes or lagoons. They are commonly found in groups which form into flocks during the autumn and winter. Scaup do not appear to show any major migratory movements, although there is little information on this.

Scaup feed on benthic aquatic invertebrates and plants on the lake bed by diving to at least two or three metres depth (Marchant & Higgins, 1993).

Breeding occurs between October and January. Nests are constructed within dense vegetation and close to water and often have entrance and exit tunnels (Marchant & Higgins, 1993, Plate 31). Clutch size is between four and eight eggs with ducklings being nidifugous (Marchant & Higgins, 1993).

Breeding occurred on both Lake Pearson and Lake Grasmere. Four broods were raised on Lake Pearson totalling 21 ducklings. Broods were raised in sites 1, 2 and 5. One nest containing an incubating female was discovered

Plate 31: Scaup nest, Site 2, Lake Pearson.

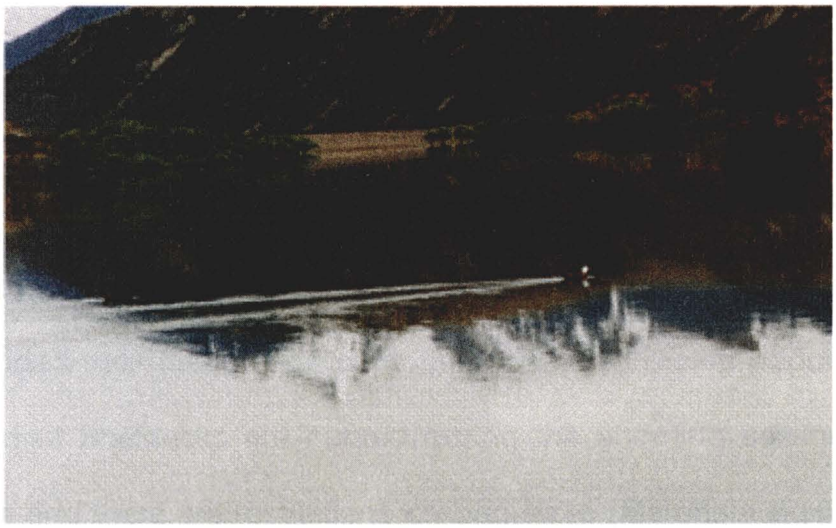


Plate 32: Paradise Shelduck pair, male on left, female on right. Site 5, Lake Pearson.

along the lake margin of site 2, Lake Pearson (Plate 31). The nest was constructed from tunnelling within a *Schoenus pauciflorus* plant and included an entrance and exit. It is suspected that seven ducklings were produced from this nest. One brood was observed on Lake Grasmere containing four ducklings.

(4.1.4) Paradise Shelduck (*Tadorna variegata*)

The Paradise Shelduck (Plate 32) is another waterfowl species endemic to New Zealand. The Paradise Shelduck national population is estimated to be approximately 120 000 with shelducks being widely distributed throughout the country (Marchant & Higgins, 1993).

Paradise Shelducks inhabit farmland, river valleys and high country lakes associated with tussock grasslands amongst the eastern foot hills of the Southern Alps (Marchant & Higgins, 1993). Prior to Polynesian colonisation of New Zealand, Paradise Shelducks were most likely to have been confined to lowland short-tussock grasslands and swamps and in lower numbers than in existing populations. With the advent of increased agricultural production in New Zealand associated with Polynesian and European colonisation, shelduck populations increased. The replacement of forests with pasture, extended their habitat and contributed to a significant population increase. Paradise Shelducks are hunted during the shooting season in controlled areas and there are restrictions on bag sizes (Marchant & Higgins, 1993).

Paradise Shelducks are predominantly herbivorous, feeding on pasture, crops, stubble and seed heads of grass and weeds. Aquatic vegetation and some insects and earthworms are eaten when available (Marchant & Higgins, 1993).

Shelducks are mostly sedentary birds with little migratory movement. During the moulting season, large flocks congregate at traditional sites from late December to early February after the breeding season. Once moult is completed, shelducks disperse back to breeding territories (Marchant & Higgins, 1993).

Breeding generally occurs from August to October, with nests constructed in hollow logs, trees or ground hollows. Clutch size is between eight and ten eggs. Ducklings are nidifugous (Marchant & Higgins, 1993). Breeding occurred on Lake Pearson in site 1 and 5. Two broods of five and three ducklings were raised in sites 5 and 1 respectively. Paradise Shelduck broods were first observed in December. No Paradise Shelduck breeding occurred on Lake Grasmere.

(4.1.5) Mallard Duck (*Anas platyrhynchos*)

Mallard ducks were first introduced into New Zealand from Australia in 1867 (Long, 1981). Mallards are now widespread throughout the country, and are by far the dominant waterfowl species. The national population for Mallard Duck was estimated to be 5 million in 1981 and still increasing (Marchant & Higgins, 1993).

Mallard ducks are present on a variety of habitats that include wetlands, grasslands, estuarine and marine environments. Mallards will also live close to human settlements (Marchant & Higgins, 1993).

Mallard ducks have an omnivorous diet feeding mostly on vegetative matter but also terrestrial and aquatic insects (Marchant & Higgins, 1993, Moon, 1992).

There is little information on migratory movements of the Mallard duck in New Zealand. Ducks will move to the sea near river mouths during the hunting season (Marchant & Higgins, 1993).

Breeding occurred on Lake Pearson only. Two broods were raised in site 2, totalling 8 juveniles (four per brood).

(4.1.6) Grey Duck (*Anas superciliosa*)

The Grey Duck is native to Australia and New Zealand. The New Zealand population has declined in recent decades due to hybridisation with the introduced Mallard Duck. During the 1960's the Grey Duck comprised 95% of the dabbling duck population, but this had been reduced to 20% in 1985 (Marchant & Higgins, 1990). The Grey Duck population in New Zealand was estimated to be 1.2 million in 1981. Concern has been expressed over the potential loss of pure Grey Ducks (Marchant & Higgins, 1990). Grey Ducks are located on a variety of habitats such as freshwater wetlands and lakes including those inland amongst mountain and forested regions. They are not found where Mallard Ducks dominate. They are restricted to undrained swamps within undeveloped regions (Marchant & Higgins, 1993).

Grey Ducks are omnivorous in diet feeding mostly on plant material, but consume aquatic insects and crustaceans on a regular basis as well (Marchant & Higgins, 1993).

There is little information on migratory movements of Grey Duck in New Zealand, however, banding information indicates that ducks disperse throughout the country. Grey Ducks are less sedentary than the Mallard

Duck (Marchant & Higgins, 1993).

Breeding occurs between August and December. Nests are constructed in ground hollows or tree holes. Clutch size is between 10 and 12 eggs. Ducklings are nidifugous.

Grey Ducks bred on Lake Grasmere only. One brood of five ducklings was raised within Grasmere stream and site 1.

(4.1.7) Mallard/Grey Duck Hybrid

Mallard and Grey Ducks often cross breed, producing fertile hybrid ducks. Hybrids now represent at least 25% of Mallard and Grey Duck populations (Marchant & Higgins, 1993).

Hybrids are thought to be uncommon in isolated and less-disturbed regions (Marchant & Higgins, 1993).

Recognition of hybrids can be difficult, particularly in non-breeding ducks, and may lead to incorrect identification of waterfowl. Distinguishing Grey Ducks and female Mallard Ducks can cause some confusion. I identified Mallards on the presence of the following characteristics: blue to purple speculum, orange legs and feet, and the absence of a cream stripe above and below the eye as is seen in the Grey Duck. Any ducks which I could not define as being either a Mallard or a Grey Duck, I classed as Mallard/Grey Duck hybrid.

(4.1.8) Australasian Shoveler (*Anas rhynchotis*)

The Shoveler is native to Australia and New Zealand (Marchant & Higgins, 1993). It is widespread throughout New Zealand although numbers vary locally. The New Zealand population of the Shoveler has been estimated as 100 000-150 000 (Marchant & Higgins, 1993).

The Shoveler is generally located in lowland, terrestrial wetlands and freshwater lakes that contain raupo, and estuarine regions. It is uncommon in high country lakes (Marchant & Higgins, 1993).

Shovelers are filter-feeders, utilizing a unique lamellae fringe present on their spatulate bill to strain zooplankton swarms from the water. This bill adaptation allows the Shoveler to capture seeds and plankton of 1 millimetre diameter (Williams, 1982). Shovelers are highly mobile and disperse widely throughout the country, otherwise there is little information available regarding their migratory movements.

Breeding has also not been well studied. Breeding occurs between October and February with solitary nests located on the ground under cover near water. Clutch sizes are suspected to be between nine and eleven eggs. As in other waterfowl species, the young are nidifugous (Marchant & Higgins, 1993).

Shovelers were recorded in very low numbers at Lake Grasmere during late spring and early summer. No breeding occurred.

(4.1.9) <u>Southern Crested Grebe</u> (*Podiceps cristatus australis*)

The Southern Crested Grebe is native (Plate 33) to Australia and New Zealand, although the species also occurs in Europe and Africa (Sagar, 1995). Within New Zealand, they are a threatened species (Marchant & Higgins, 1993).

The New Zealand population was estimated to be between 200 and 250

a)

b)

Plate 33: Crested Grebe, **a)** Site 3, Lake Pearson. **b)** adult with juvenile (aged approx. 6 weeks).

birds in 1980 (Sagar, 1981) and remain steady at that level at the current time. 70% of the population are found east of the Southern Alps, in Canterbury.

The Crested Grebe is confined to alpine, high country, and some lowland coastal lakes along the Southern Alps in the South Island. Lakes are oligotrophic, with high clarity and surrounded by tussock grassland, willow trees, sedges and reed beds (Marchant & Higgins, 1993, O'Donnell, 1982). The Crested Grebe leads an entirely aquatic existence, rarely venturing on to land. Grebes are piscivorous, diving for fish in open water. Dives usually last for between 20-30 seconds but can be close to a minute (Marchant & Higgins, 1993, Westerskov, 1974).

Crested Grebes are monogamous maintaining pair-bonds throughout the year. Territories are maintained during the breeding season which occurs from September through to May. Elaborate courtship displays, unique to the species, are performed during this period. Nesting occurs between late November and January (Marchant & Higgins, 1993, Westerskov, 1974). This is considerably later than other bird species, with many waterfowl beginning to nest in September or October. Nests are constructed as floating platforms which are attached to submerged vegetation such as willow tree branches, *Carex secta* plants or reeds (Plate 34,35). Clutch size is between two and four eggs (Marchant & Higgins, 1993, Westerskov, 1974). Chicks are semi-nidicolous (live in nest for a time after hatching) and are carried on the parents back under the wings. Chicks can swim two days after hatching and dive after one week (Plate 33) (Marchant & Higgins, 1993).

Plate 34: Typical Crested Grebe breeding habitat, Site 2, Lake Pearson.

Plate 35: Crested Grebe nest containing three eggs, Site 3, Lake Pearson.

Crested Grebes move between many lakes during summer and concentrate on ice-free lakes in winter. Severe winters may induce larger-scale movements to coastal lakes such as Lake Forsyth (Marchant & Higgins, 1993; Sagar & O'Donnell, 1982) but not always (O'Donnell, 1988). However many birds will remain on iced lakes feeding in ice-free patches (Marchant & Higgins, 1993).

The decline in the Crested Grebe population within New Zealand has been attributed to many factors. Nests may be flooded or stranded by fluctuating water levels from hydro-lake manipulations. Human recreation activities particularly power boating and waterskiing, can disrupt and destroy nests. Eutrophication of lakes resulting in the alteration of fish populations has an impact as well (Westerskov, 1971).

(4.1.10) Black Shag (*Phalacrocorax carbo novaehollandiae*)

The Black Shag is a cosmopolitan species, and is widely distributed throughout New Zealand (Moon, 1992, Marchant & Higgins, 1993). It is found within terrestrial wetlands, deep, open, freshwater lakes and rivers, and along the coast. Shags are not affected by salinity and turbidity fluctuations (Marchant & Higgins, 1993).

The diet of Black Shags consists of predominately fish, with some crustaceans and insects consumed in freshwater. Shags dive for fish, with most dives lasting 25-30 seconds.

There is no information on Black Shag movements within New Zealand, but they are distributed widely after breeding in Australia (Marchant & Higgins, 1993).

Breeding occurs in colonies along cliff ledges, on the ground of small islands, and in trees (Moon, 1992). Clutch size is between three and five eggs (Marchant & Higgins, 1993). No birds bred within Lakes Pearson and Grasmere.

(4.1.11) Little Shag (*Phalacrocorax melanoleucos brevirostris*)

The Little Shag is found throughout New Zealand in coastal waters, inland freshwater lakes and wetlands (Moon, 1992). The population within New Zealand is estimated to be between 10 000 and 50 000.

Little Shags feed on fish and freshwater crustaceans by diving underwater. Shags dive separately not in groups (Marchant & Higgins, 1993; Moon, 1992).

Breeding occurs between August and March, with nests constructed in trees and low bushes within colonies. Clutch size is between three and four eggs (Moon, 1992; Marchant & Higgins, 1993).

There are no records of migration within New Zealand for the Little Shag (Marchant & Higgins, 1993).

(4.1.12) White-faced Heron (*Ardea novaehollandiae*)

The White-faced Heron was self-introduced into New Zealand from Australia late last century, with the first documented record made by Buller, (1868). Breeding was first recorded in 1941 and the White-faced Heron is now widely distributed throughout New Zealand from the coast to 500m a.s.l., being rare above this altitude (Marchant & Higgins, 1993).

White-faced Herons occur in estuaries, inland wetlands, and pastoral land (Marchant & Higgins, 1993; Carroll, 1967).

Feeding predominant occurs in shallow water, exposed mudflats, and flooded pastures, both in freshwater and estuarine habitats Marchant & Higgins, 1993). The diet of the White-faced Heron consists of aquatic vertebrates and invertebrates including frogs, fish and insects (Carroll, 1967,; Marchant & Higgins, 1993).

In New Zealand, White-faced Herons migrate to the coast for the winter, otherwise they are regarded as sedentary. Local flocks may move 10 to 20 kilometres a day between local feeding and resting sites (Marchant & Higgins, 1993).

There is little information on the breeding of the White-faced Heron. Nesting occurs between June and December in trees of shrubs often in open country. Clutch size is between three and five eggs (Marchant & Higgins, 1993). Young are nidicolous (Marchant & Higgins, 1994)

No breeding occurred at Lakes Pearson or Grasmere.

(4.1.13) Spur-winged Plover (*Vanellus miles*)

The Spur-winged Plover was self-introduced from Australia during the 1930's. There is little information on their population numbers in New Zealand they are widespread around the country and can be found in open pasture, riverbeds, lake margins and sheltered coasts (Moon, 1992; Marchant & Higgins, 1996).

Spur-winged Plovers feed on a variety of invertebrates including some marine crustaceans (Marchant & Higgins, 1996; Moon, 1992).

Plovers will form into flocks during autumn and winter in local regions. Plovers disperse from flocks to breeding territories in May and June

Plate 36: Pied Stilt feeding in shallow water, Site 1, Lake Pearson.

(Marchant & Higgins, 1996).

Breeding occurs from early June to late November. Nests are constructed in paddocks, wet ground near swamps

or in stony ground (Marchant & Higgins, 1996; Moon, 1992). Clutch size is between three and four eggs. Chicks are nidicolous.

No breeding was recorded on the lake margins of Lakes Pearson and Grasmere.

(4.1.14) Pied Stilt (*Himantopus himantopus*)

The Pied Stilt (Plate 36) is a cosmopolitan species, widely distributed in Australia and New Zealand. The population within New Zealand in 1984 was estimated to be approximately 30 000 (Marchant & Higgins, 1996).

The Pied Stilt is found in coastal and inland regions, on shingle banks in braided river beds, mudflats, lagoons, swamps and open pasture (Marchant & Higgins, 1996; Moon, 1992).

Pied Stilts feed on aquatic and terrestrial crustaceans, molluscs, and insects (Marchant & Higgins, 1996; Moon, 1992).

Pied Stilts migrate to the coast during late summer and autumn to spend the winter. Large flocks overwinter in the Waikanae estuary Birds leave for breeding grounds in early spring (Marchant & Higgins, 1996).

Breeding occurs from July to December. Nests are established close to water in riverbeds, swamps, ponds, and estuaries in a scrape in the ground (Marchant & Higgins, 1996; Moon, 1992). Clutch size is between two and four eggs.

No Pied Stilt breeding occurred on the lake margins of Lake Pearson and

Grasmere.

(4.1.15) Banded Dotterel (*Charadrius bicinctus*)

The Banded Dotterel is native to New Zealand. The New Zealand population is approximately 13 000 (Marchant & Higgins, 1996).

Dotterels are found in dry, open and stable areas of shingle, particularly on the banks of braided river beds but also along coasts and estuaries. They can reach high altitudes, located within dry, montane habitats (Marchant & Higgins, 1996).

The Banded Dotterels feed on terrestrial and aquatic invertebrates. They forage on vegetated shingle beds, closely cropped pastures and mudflats (Marchant & Higgins, 1996).

Dotterels that are located inland are entirely migratory, mainly due to rivers being an unreliable source of food. During autumn, dotterels migrate to coastal estuaries in the Far North of the North Island or to Australia to spend the winter (Marchant & Higgins, 1996).

Breeding occurs from August to December (Moon, 1992). Dotterels nest in braided river beds with the nest being a simple scrape in the ground. Clutch size usually consists of three eggs (Marchant & Higgins, 1996; Moon, 1992).

(4.1.16) South Island Pied Oystercatcher (*Haematopus finshi)*

The South Island Pied Oystercatcher is endemic to New Zealand. They are predominantly located in the South Island, but are scattered along the coast of the North Island (Marchant & Higgins, 1996). The national population in 1970/71 was close to 49 000 birds (Marchant & Higgins, 1996).

The South Island Pied Oystercatcher is found along the coasts during winter and inland to 1800 metres a.s.l during the breeding season. Oystercatchers inhabit paddocks, shingle beds and sand banks of braided river beds. At high altitudes, they may be found in subalpine tundra (Marchant & Higgins, 1996).

The South Island Pied Oystercatcher feed on predominantly molluscs, worms, crustaceans and sometimes insects and small fish (Marchant & Higgins, 1996; Moon, 1992).

The South Island Pied Oystercatcher migrates within New Zealand to North Island harbours and estuaries to spend the winter. Oystercatchers leave the South Island during January and early February (Marchant & Higgins, 1996).

Breeding occurs between early August and October, on braided riverbeds, beaches and in paddocks within the South Island (Marchant & Higgins, 1994; Moon, 1992). Nests are constructed in a scrape in the ground, clutch size is generally two and three eggs.

No breeding occurred at Lakes Pearson or Grasmere.

(4.1.17) Black-backed Gull (*Larus dominicanus*)

The Black-backed Gull is the most common gull in New Zealand and occurs from the coast to subalpine altitudes (Moon, 1992).

Black-backed Gulls occur on a variety of habitats including harbours, estuaries, and inland regions (Moon, 1992). Gulls are carnivorous and scavengers. They feed on fish, molluscs, worms, insects and sometimes carrion (Marchant & Higgins, 1996; Moon, 1992).

Gulls leave breeding areas during the winter, and may migrate to the coast. Breeding occurs from November to January, with nests constructed on rocky headlands, beaches, river gorges and along lakes and mountainsides at high altitudes (Marchant & Higgins, 1996; Moon, 1992). Clutch size is generally two and three eggs.

(4.1.18) Black-fronted Tern (*Sterna albostriata*)

The Black-fronted Tern is endemic to New Zealand and is found throughout braided river beds and farmland east of the Southern Alps (Marchant & Higgins, 1996, Moon, 1992). There is no population estimate available for this species (Marchant & Higgins, 1996).

Black-fronted Terns feed on small fish, insects and earthworms (Moon, 1992). Terns migrate to coastal estuaries in the South and North Islands during autumn to spend the winter (Marchant & Higgins, 1996, Moon, 1992).

Black-fronted Terns return to their breeding grounds in the braided river beds of the South Island. Breeding occurs between mid October to December (Marchant & Higgins, 1996, Moon, 1992). Nests consist of a scrape in the ground with a clutch size of two and three eggs.

(4.1.19) Australasian Harrier *(Circus approximans)*

Harriers occur both here in New Zealand and in Australia in open country and along the forest margins (Moon, 1992).

Harriers are carnivores and their diet consists of small mammals, birds and rodents.

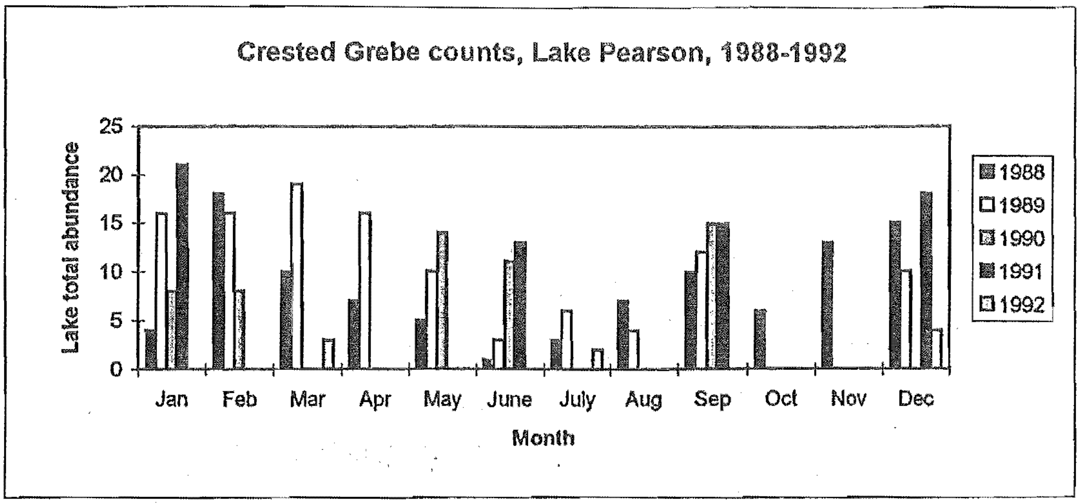


Figure 4.0

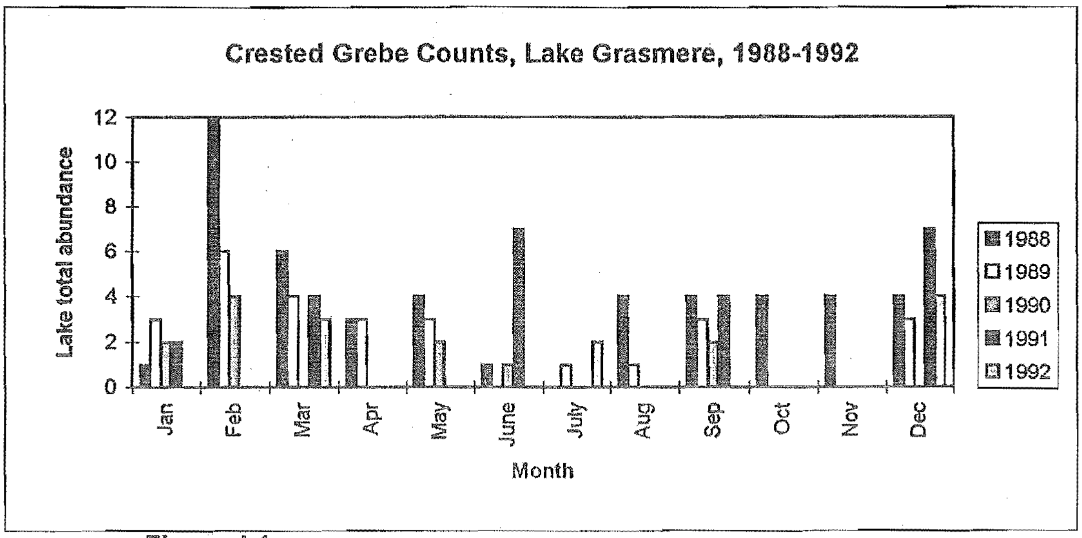


Figure 4.1

Breeding occurs from August to November with nests built in swamps. Clutch size is three and four eggs.

(4.1.20) Pipit *(Anthus novaeseelandiae novaeseelandiae)*

The Pipit is found at high altitudes on rocky terrain, sand dunes and grasslands. Breeding occurs from September and February with nests constructed in grass. Clutch size is between three and four eggs (Moon, 1992).

(4.1.21) Australian Magpie *(Gymnorhina tibicen)*

Magpies were introduced into New Zealand from Australia during the 1860's and is now widespread around the country (Moon, 1992).

Magpies are omnivorous, feeding on invertebrates, seeds, vegetation and carrion.

Breeding begins in June. Nests are constructed in trees, with clutch size between two and four eggs.

4.2 EXISTING DATA

Bird censuses have been undertaken on the high country lakes of the Waimakariri basin by the Department of Conservation from 1988 to 1992. Although this monitoring programme has now ceased, it enabled a data base of bird abundances to be established. Counts were not taken in regular intervals during 1991 and 1992.

(4.2.1) Crested Grebe

(a) Lake Pearson The Crested Grebe count data from 1988 to 1992, does not show any strong pattern in terms of whether the grebe population is increasing or declining (Fig 4.0). My data shows some resemblance to 1992 Crested Grebe count data. Further study on the demographics of Crested Grebe is needed before any definite conclusions can be made on the population at Lake Pearson.

(b) Lake Grasmere Crested Grebe counts from Lake Grasmere, 1988-1992 do not show any strong patterns in the demography of the species (Fig 4.1). Abundances are consistently lower at Lake Grasmere than found on Lake Pearson.

(4.2.2) Scaup

(a) Lake Pearson Scaup demonstrate a stable population at Lake Pearson (Fig 4.2). Numbers fluctuate between years, but again no definite patterns can be defined within the data set.

(b) Lake Grasmere With similarities to Lake Pearson, Scaup numbers remain stable, with some fluctuations in population size between years, Again no trends can be determined from the data (Fig 4.3).

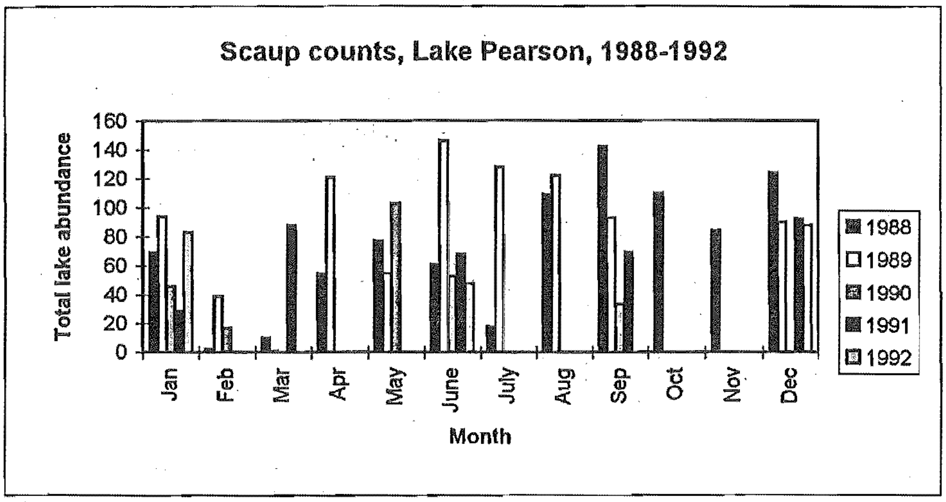


Figure 4.2

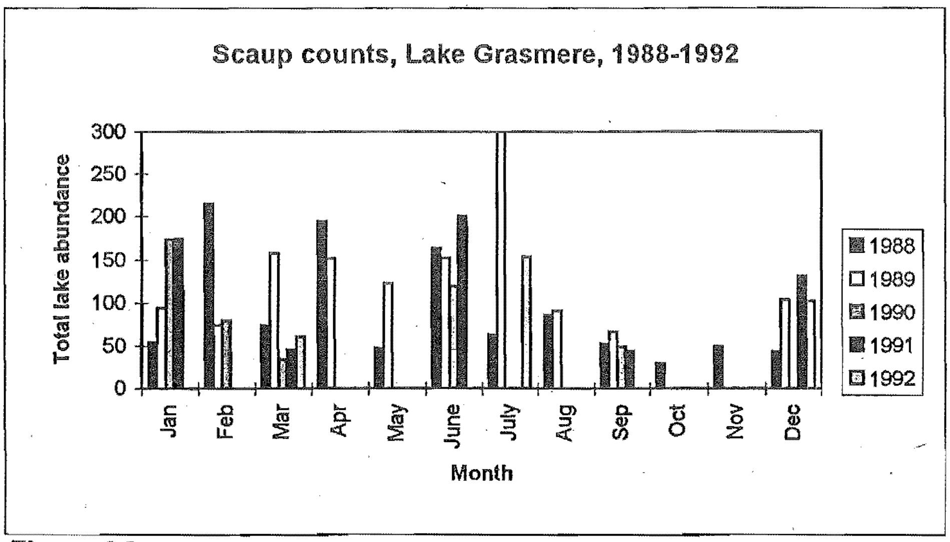


Figure 4.3

CHAPTER FIVE

RESULTS

5.1 SPECIES COMPOSITION

Lake Pearson and Lake Grasmere differ in the species composition of their bird communities. Some species are shared by the two lakes, others are only found on one of the lakes. Lake Pearson demonstrated both the greatest species and family richness of the two lakes. Species from eleven bird families occur on Lake Pearson and nine on Lake Grasmere at some stage throughout the year. The species richness is greater than Lake Grasmere both in terms of number of species and number of bird families. For the majority of the research period, Lake Pearson had a greater number of species observed per month than Lake Grasmere (Fig 5.0). The exception occurred in April when Lake Grasmere had a greater number of species observed. The greatest difference in species richness between the two lakes occurred in September and October. This was a difference of five species between the two lakes. The lakes only differed by one species during the months of March, April, August and January. Species richness was at its minimum level at Lake Pearson during April, and at Lake Grasmere in September and October equally. Maximum species diversity for both lakes occurred in January.

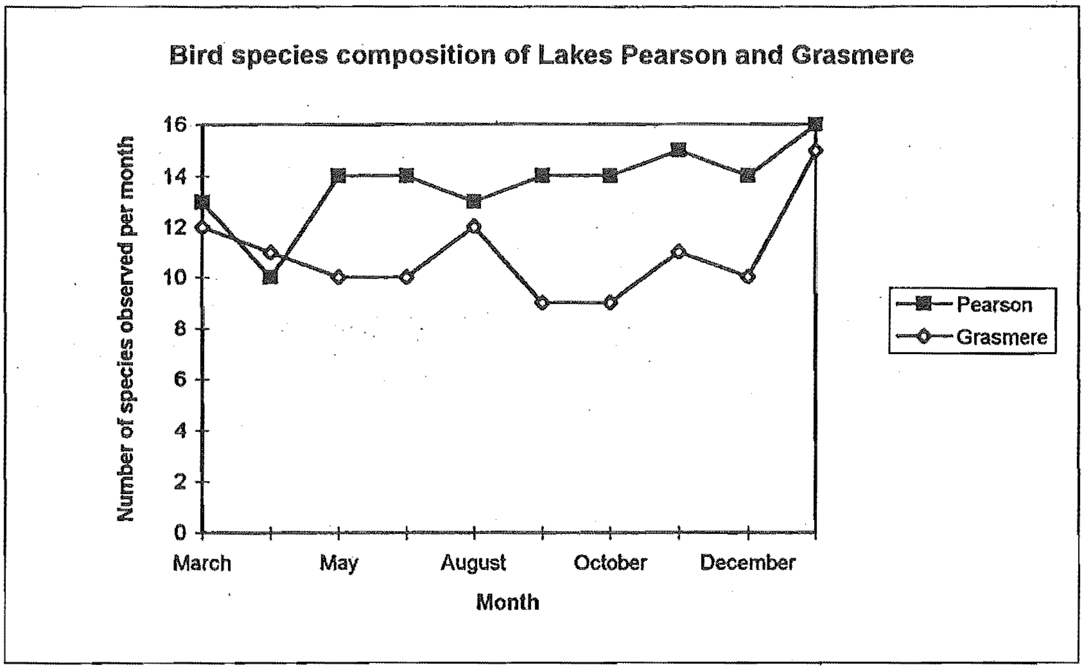

Bird species composition of Lakes Pearson and Grasmere
Number of species observed per month
16
14
12
10
8
6
4
2
0
March
May
August
October
December
Month
Pearson
Grasmere

Figure 5.0

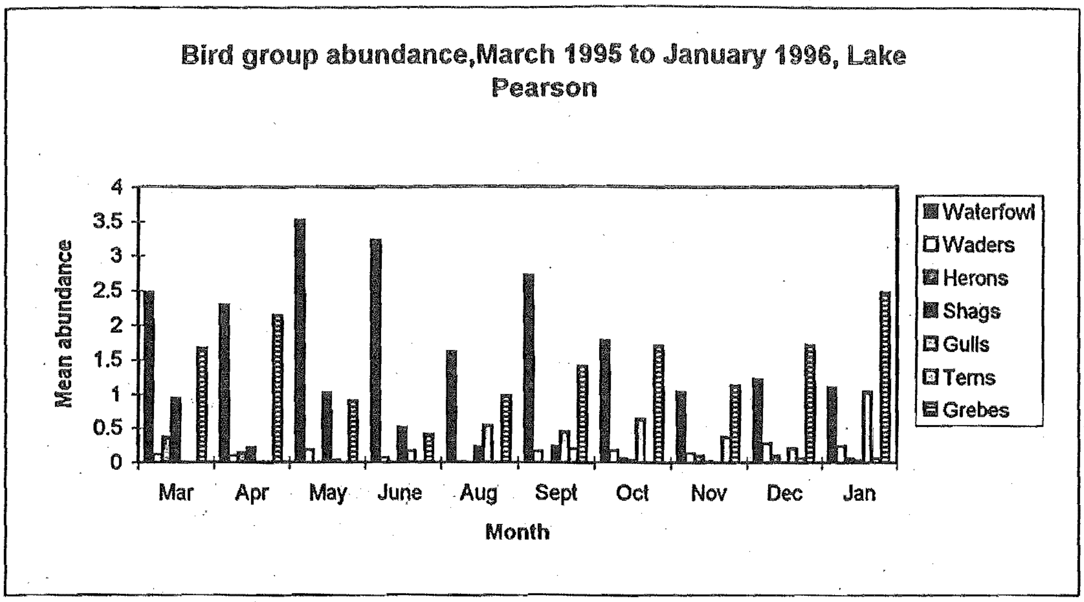


Figure 5.1

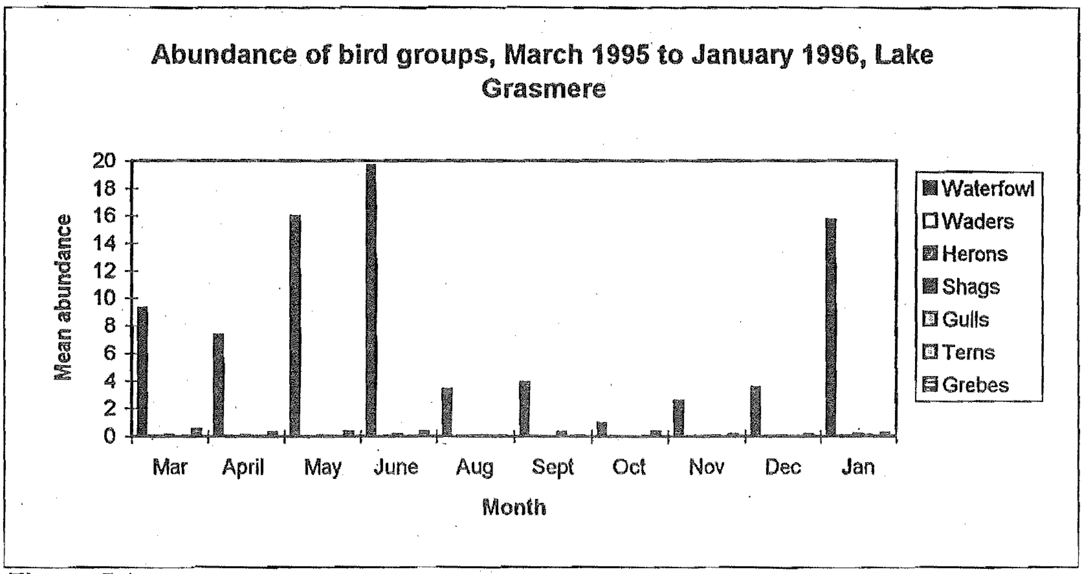


Figure 5.1a

Figure 5.2: Mean abundance over all sites from March 1995 to January 1996

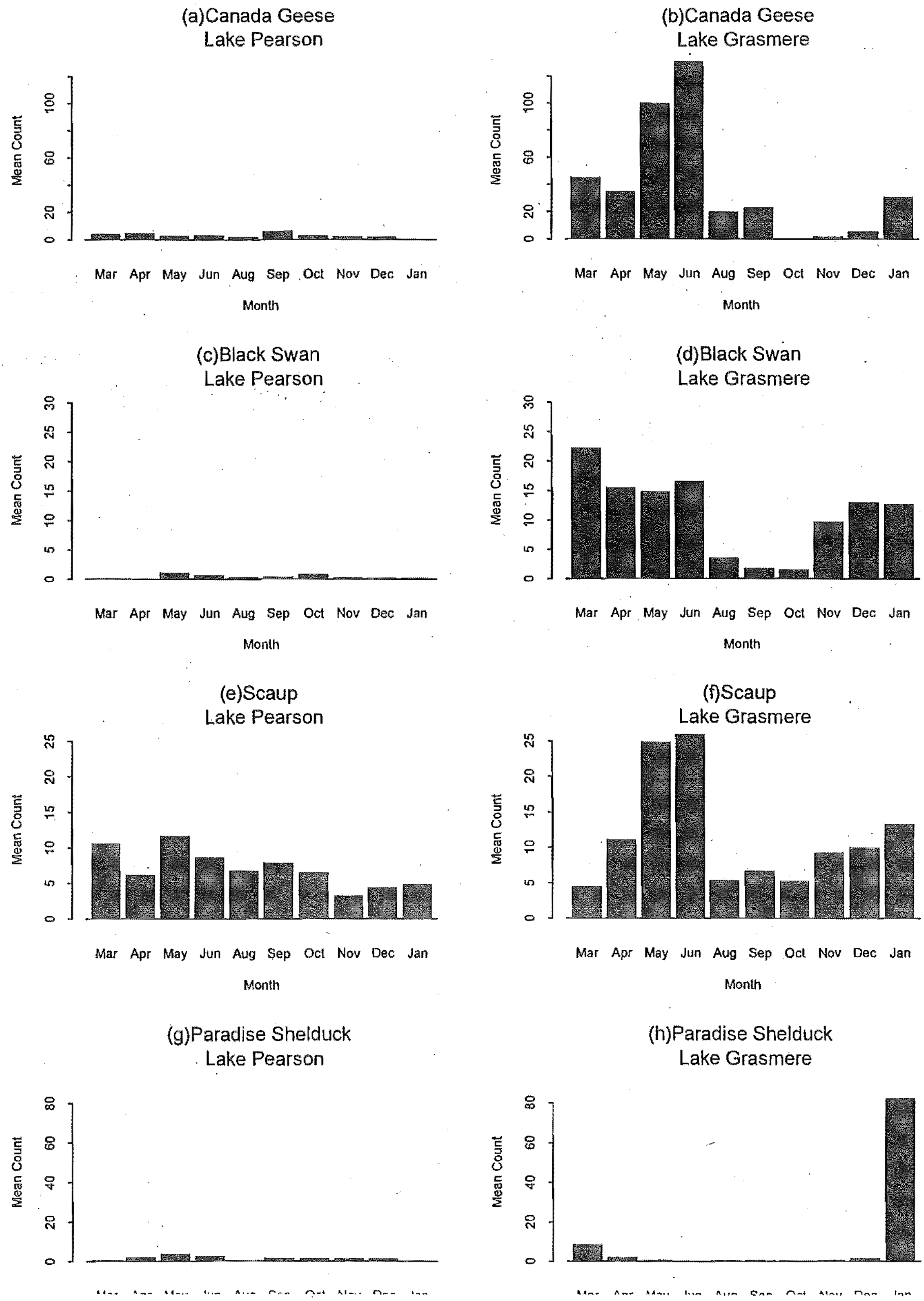


Figure 5.3: Mean abundance over all sites from March 1995 to January 1996

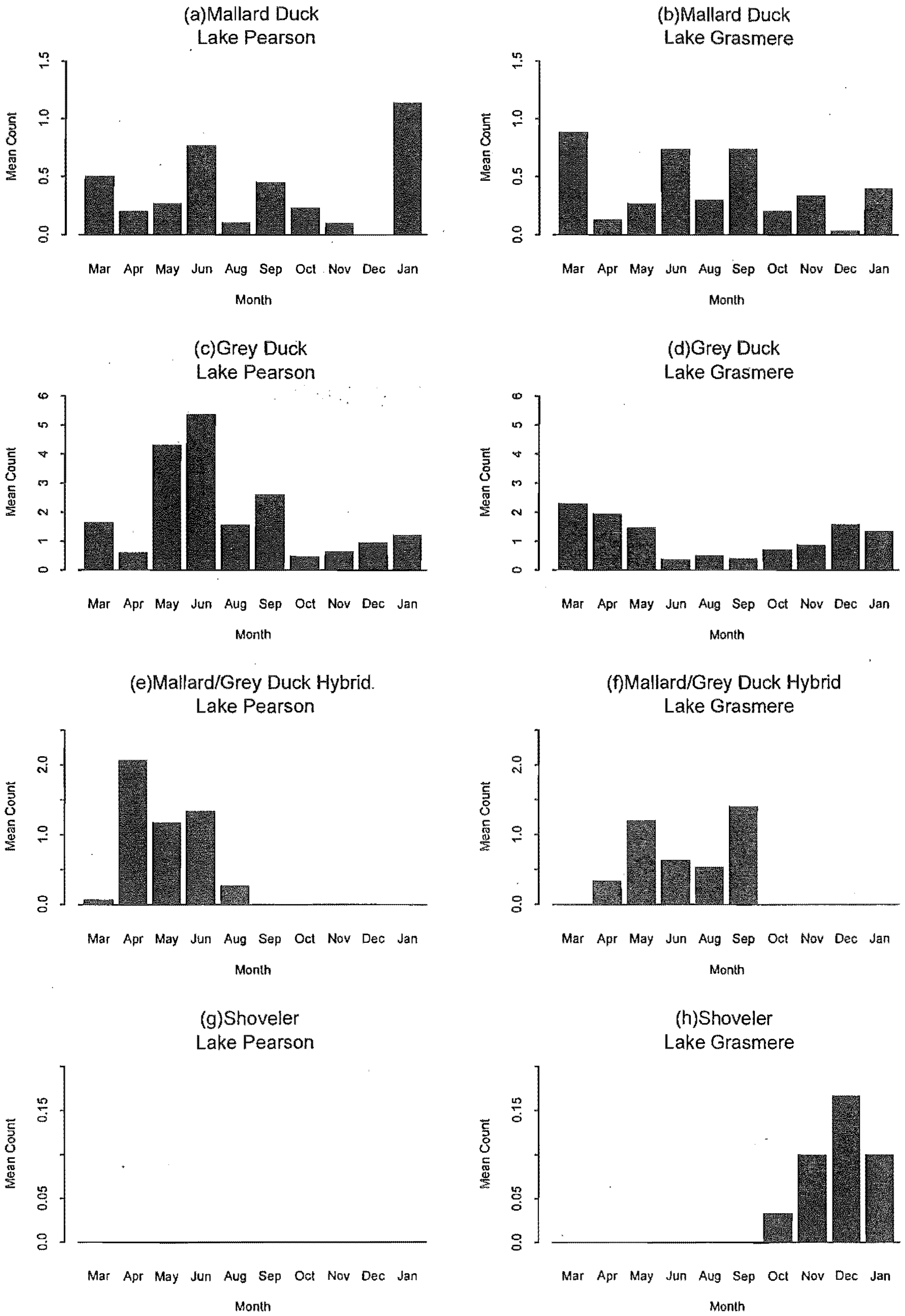


Figure 5.4: Mean abundance over all sites from March 1995 to January 1996

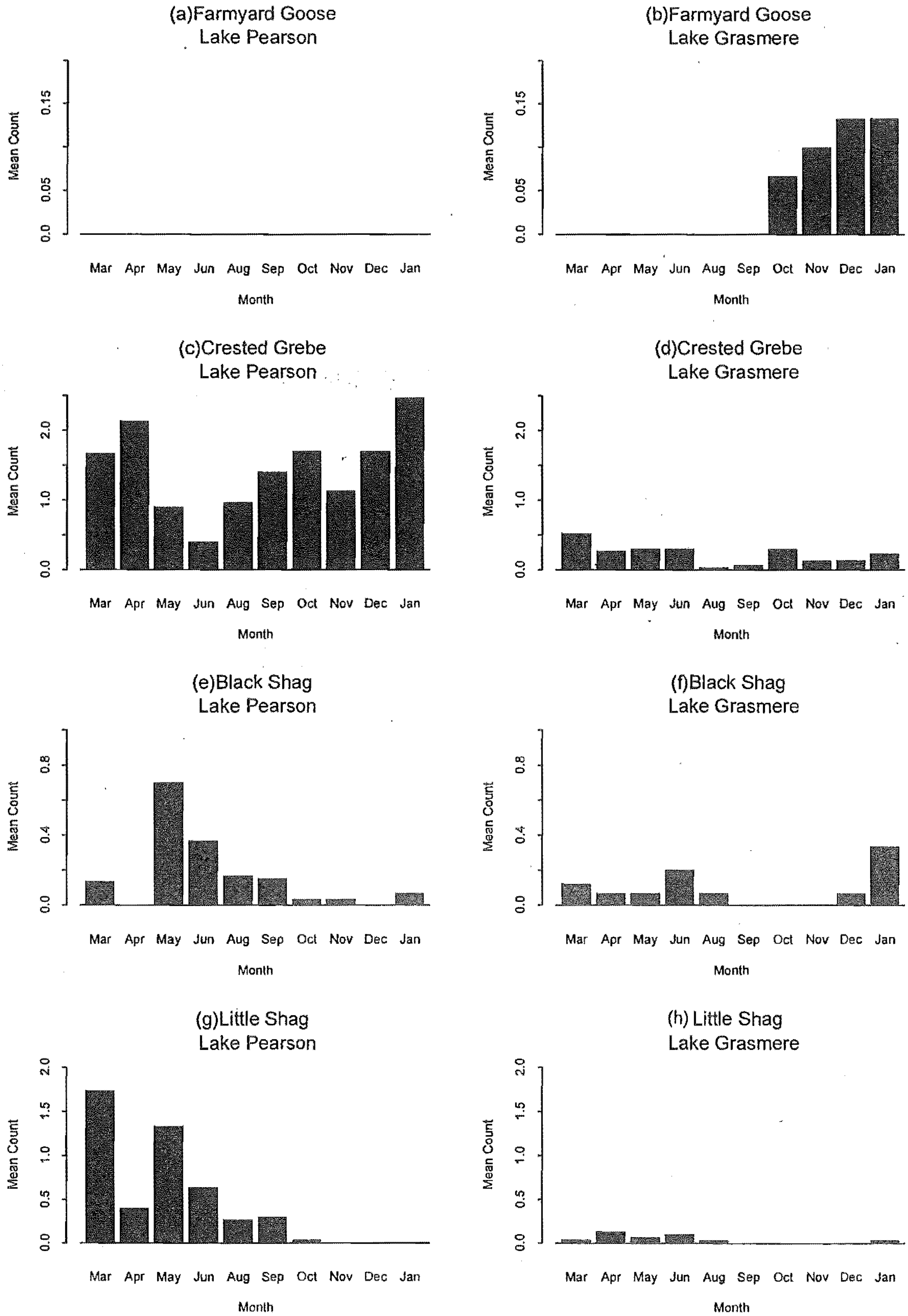


Figure 5.5: Mean abundance over all sites from March 1995 to January 1996

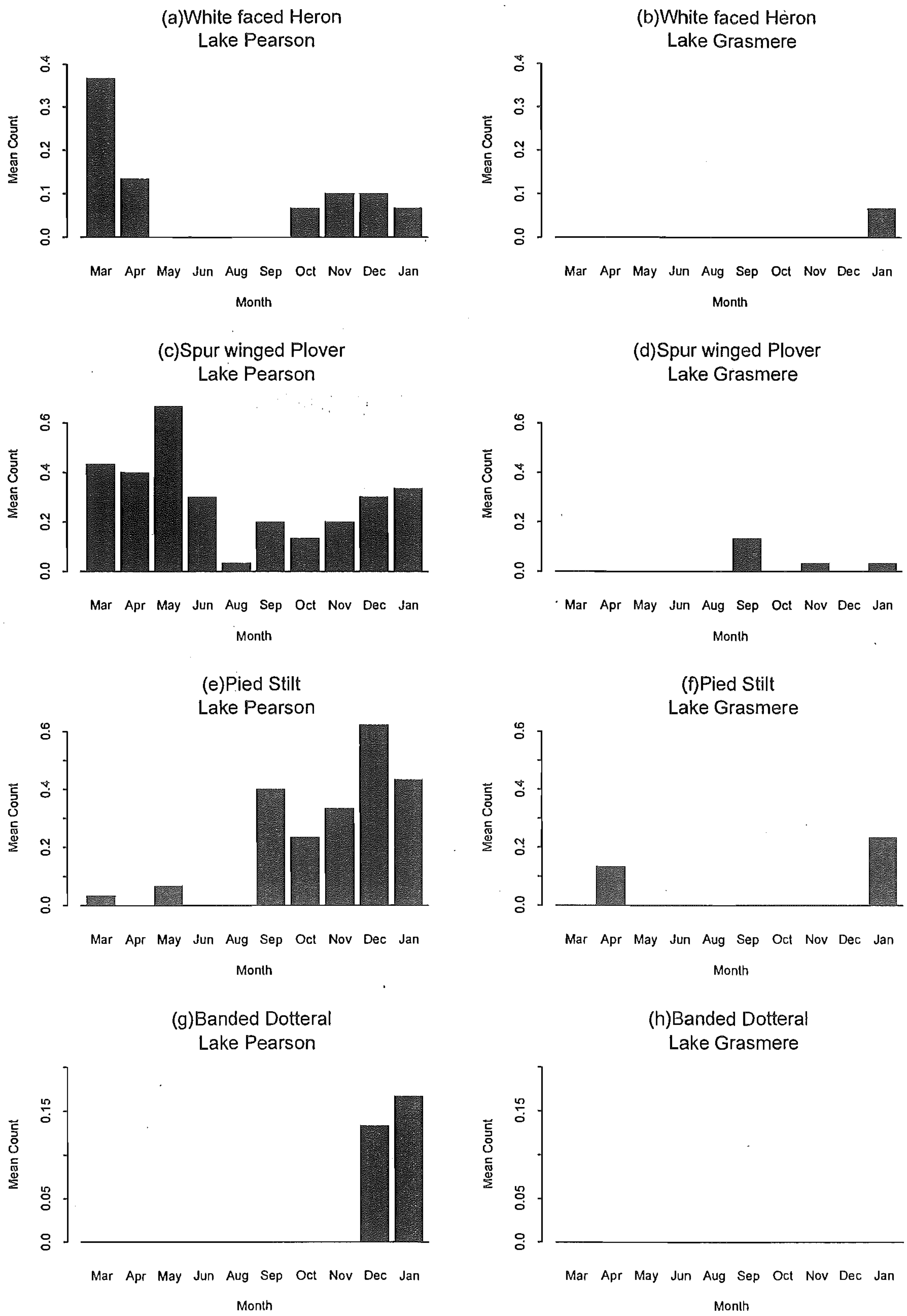


Figure 5.6: Mean abundance over all sites from March 1995 to January 1996

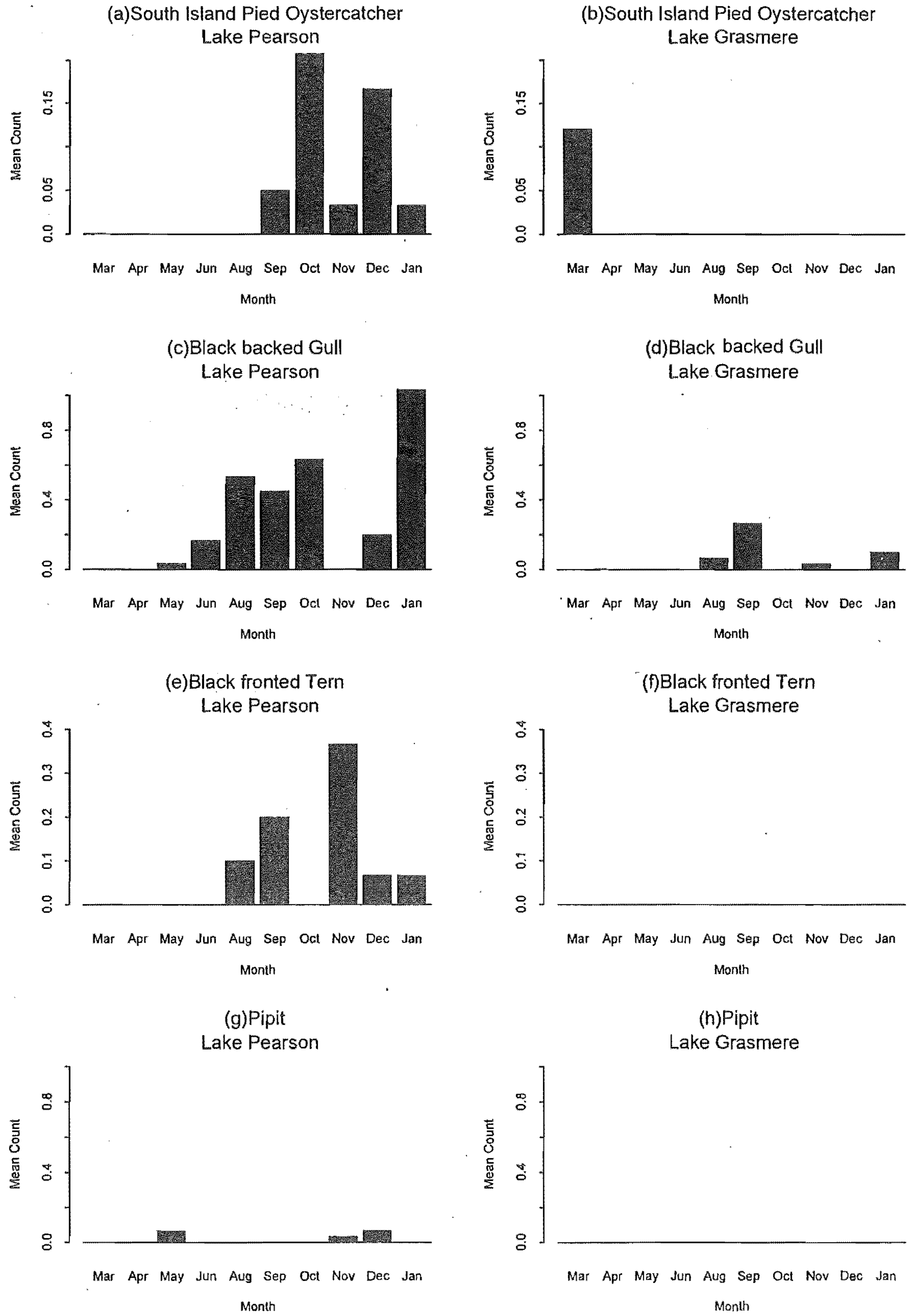
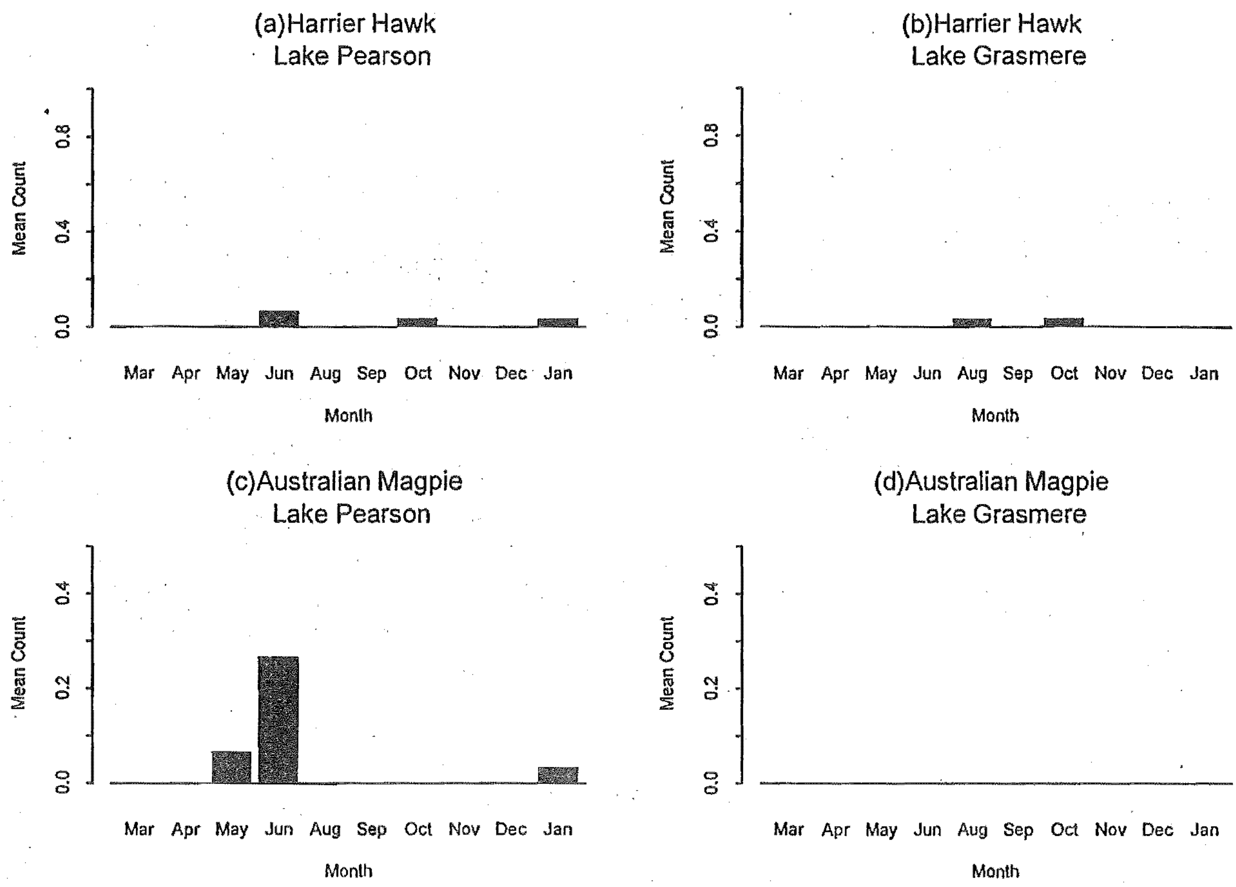


Figure 5.7: Mean abundance over all sites from March 1995 to January 1996



(5.1.1)Lake Pearson

Members of the orders Anseriformes (waterfowl), Charadriiformes (waders, gulls and terns), Ciconiformes (herons, bitterns and egrets), Pelecaniformes (gannets and cormorants/shags), Podicipediformes (grebes), Falconiformes (falcons and harriers), Passeriformes (Perching birds, (Pipit and Magpie)) were all recorded on Lake Pearson at some stage during the research period. Waterfowl, grebes and waders were recorded on the lake throughout the study where as herons, shags, gulls and terns were present intermittently.

(5.1.1.1) Order Anseriformes (Waterfowl)

Waterfowl were the dominant birds in the Lake Pearson bird community both in terms of abundance and in species numbers (Fig 5.0, 5.1). The waterfowl group contained seven species of which the majority were present on Lake Pearson throughout the research period.

Scaup were consistently the dominant species within the waterfowl community (Fig 5.2e). Black Swan was the least abundant species for most of the research period except for May and October, when Mallard Duck were the least abundant. Grey Duck abundance was consistently greater than that of Mallard. Canada Geese was generally the second most abundant species, but abundance fluctuated with that of the Paradise and Grey Ducks.

(5.1.1.2) Order Charadriiformes (Waders, Gulls and Terns)

Gulls exhibited the greatest abundances for the majority of the research period out of all three families that represent the Charadriiformes on Lake Pearson (Fig 5.5a-h, 5.6a-f). Gulls were represented by only one species, the Black backed Gull on Lake Pearson.

Waders were present on the lake throughout the research period. However, the numbers of waders were generally lower than of the gulls and, in September and November, terns. Waders were composed of four species; the South Island Pied Oystercatcher, Spur-winged Plover, Pied Stilt and Banded Dotterel (Fig 5.6a, 5.5c,e and g). This group includes three separate families: Haematopodidae, Recurvirostridae and Charadriidae. The dominant wading species were the Spur-winged Plover (from March to August) and the Pied Stilt (from September to January with the exception of October). In October, the South Island Pied Oystercatcher exhibited the greatest abundance. Terns were only present during the spring and summer with mean abundances in between those exhibited by gulls and waders. Only one tern species, the Black-Fronted Tern, was represented in Lake Pearson.

(5.1.1.3) Order Pelecaniformes (Shags)

Only two shag species frequented Lake Pearson with the Little Shag becoming dominant over the Black Shag when both were present (Fig 5.4e,g). The Black Shag was present on Lake Pearson for a greater length of time than the Little Shag.

(5.1.1.4) Orders Podicipediformes and Ciconiformes

Orders Podicipediformes (Grebes) and Ciconiformes (herons, bitterns and egrets) contained one species each, the Crested Grebe (Fig 5.4c) and White-faced Heron (Fig 5.5a) respectively.

(5.1.2) Lake Grasmere

Members of the orders Anseriformes, Charadriiformes, Ciconiformes, Pelecaniformes and Podicipediformes, Falconiformes and Passeriformes were all recorded on Lake Grasmere at some stage during the research period. Waterfowl and grebes were present throughout the research period; shags, gulls, waders and terns were present less frequently (in descending order).

(5.1.2.1) Order Anseriformes (Waterfowl)

Waterfowl was by far the dominant bird order of the Lake Grasmere bird community (Fig 5.2b,d,f,h, 5.3b,d,f,h, 5.4b) containing nine species. The dominant species for five months (March to September excepting August) of the research period was Canada Geese (Fig 5.2a). For the remaining months, dominant species included Scaup and Black Swan with Paradise Shelduck exhibiting greatest mean abundance during January. The dabbling duck were not as prominent as the geese and swans; Grey, Mallard and Grey/Mallard hybrid ducks and Shoveler (Fig5.3b,d,f,and h) had consistently reduced numbers than the dominant species.

(5.1.2.2) Order Pelecaniformes (Shags)

Two shag species were present on Lake Grasmere, with the Black Shag being the dominant species over the Little Shag (Fig 5.4f,h). The exception occurred during April where the Little Shag exhibited a greater mean abundance than the Black Shag. Black Shags were recorded on Lake Grasmere for seven months of the research period, while the Little Shag was recorded for six.

(5.1.2.3) Order Charadriiformes (Waders, Gulls and Terns)

Members of this order visited Lake Grasmere spasmodically throughout the research period (Fig 5.5b,d,f,h, 5.6d,f,). Gulls consistently exhibited a greater abundance than waders. As on Lake Pearson, only one species from this group was represented on Lake Grasmere, the Black-backed Gull.

Waders were represented by three species, the South Island Pied Oystercatcher, Spur-winged Plover and the Pied Stilt (Fig 5.6b,5.5d and f). The Pied Stilt exhibited the greatest abundance compared with the other species, particularly during January. The Spur-winged Plover was present during three months of the research period with maximum mean abundance for the species occurring in September. The South Island Pied Oystercatcher was only present in March.

No terns were recorded on Lake Grasmere.

(5.1.2.4) <u>Order Podicipediformes and Ciconiformes</u>(Grebes and Shags)

The Crested Grebe and White faced Heron were recorded on Lake Grasmere.

5.2 BIRD ABUNDANCES

Statistical analysis was attempted for all bird species. However a model could not be fitted for some species (the model would not converge) primarily due to very low or infrequent abundances. These species included White-faced Heron, Pied Stilt, South Island Pied Oystercatcher, Spur-winged Plover, Black- fronted tern, Shoveler, Farmyard Goose, Harrier Hawk, Pipit and Australian Magpie. Bird species that did fit the model are presented below.

(5.2.1)Waterfowl

(5.2.1.1) Canada Geese

(a) Lake Pearson Canada Geese abundance on Lake Pearson was consistently low throughout the year (Fig.5.2a). Maximum abundance was recorded in September, and this was folloed by a gradual decrease during spring and summer. No Canada Geese were counted during January.

The geese would feed and rest, as one flock, particularly during the winter months. Feeding often occurred on Flock Hill Station paddocks, adjacent to Site 5.

(b) Lake Grasmere Canada Geese were a major component of the waterfowl community of Lake Grasmere. Canada Geese exhibited the highest abundance of any other species observed on the lake. The Canada Geese community of Lake Grasmere was an order of magnitude greater in size than that of Lake Pearson (Fig 5.2b). Canada Geese numbers demonstrated seasonal patterns. Numbers were greatest during the winter with peak abundance occurring in June. A considerable drop in abundance was recorded in August with the onset of spring. However, numbers increased again in January. The geese remained in large flocks and would feed and rest together simultaneously. In winter, flocks would typically feed on paddocks adjacent to Lake Grasmere followed by resting and limited feeding on the lake itself.

(c)Analysis

Table 1. Bird Abundance Analysis of Deviance Table for Canada Goose

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	10712.33	22.75	0.000
Month	9	11219.48	23.83	0.000
Site in Lake	8	8220.98	17.40	0.000
Lake by Month	9	1178.03	2.50	0.000
Site in Lake by Month	72	3418.93	7.26	0.000
Residual	440	12326.60	26.18	
Total	539	47076.34		

All factors and interactions were highly significant ($P<0.001$) for Canada Geese (Table 1). Month accounted for 23.83% of the deviance, reflecting the seasonal trends, especially the very large abundances that were recorded in June on Lake Grasmere (Fig 5.2b). Lake accounted for 22.75% of the deviance, reflecting the higher abundance of Canada Geese at Lake Grasmere with comparison to that of Lake Pearson (Fig 5.2a). Site (within lake) accounted for 17.4% of the deviance explained. The interactions lake by month and site (within lake) by month only accounted for 2.50% and 7.26% of the deviance. The overall model fit is very high, with 73.82% of the deviance explained.

(5.2.1.2) Black Swan

(a) Lake Pearson. Black Swans were found in consistently low abundances on Lake Pearson (Fig 5.2c). Maximum abundance was recorded during the months of May and October with slightly reduced abundances during winter and summer. No Black Swans were recorded in April.

(b) Lake Grasmere. Black swans were present on Lake Grasmere in all sampled months (Fig 5.2d). Seasonal population fluctuations were apparent with maximum abundance recorded in March, declining to a minimum in October. Swan numbers gradually increased again during summer.

(c) Analysis

Table 2. Bird abundance analysis of Deviance Table for Black Swan

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	3424.88	37.52	0.000
Month	9	1040.43	11.49	0.000
Site in Lake	8	2042.79	22.37	0.000
Lake by Month	9	172.59	1.80	0.000
Site in Lake by Month	72	1000.97	10.90	0.000
Residual	440	1437.16	15.74	
Total	539	9127.85		

All factors and interactions were highly significant ($P<0.001$)for Black Swan (Table 2). Lake accounted for 37.52% of the deviance. Fig 5.2d demonstrates that Black Swan abundance on Lake Grasmere is significantly greater than that found on Lake Pearson (Fig 5.2c). Site (abbreviation used from here onwards, for site (within lake)) accounted for 22.37% of the deviance. Month accounted for 11.49% of the deviance and was closely followed by site by month interaction which accounted for 10.90% of explained deviance. The overall model fit is very high with 84.08% of the deviance explained.

(5.2.1.3) Scaup

(a)Lake Pearson. Scaup were present on Lake Pearson consistently throughout the research period with only slight fluctuation in numbers (Fig 5.2e). Seasonal patterns were not very pronounced in the Scaup community of Lake Pearson. Maximum and minimum abundances were recorded in May and November respectively. Scaup generally remained in groups which formed into flocks over winter.

(b) Lake Grasmere. Scaup were observed throughout the research period on Lake Grasmere (Fig 5.2f) although abundance was not consistent. Fluctuations in abundance were distinctive, particularly from March to August. Minimum abundance was recorded in March from which followed a steep increase in bird numbers particularly during May. Maximum abundance was recorded in June followed by a sharp decrease during August. Scaup mean numbers remained low over the spring months with an increase in abundance occurring from November onwards as summer progressed.

(c) Analysis

Table 3. Bird abundance analysis of Deviance Table for Scaup

Effect	df	Deviance	%Deviance	Pr(Chi)
Lake	1	366.91	2.87	0.000
Month	9	1043.35	8.16	0.000
Site in Lake	8	972.62	7.61	0.000
Lake by Month	9	463.88	3.62	0.000
Site in Lake by Month	72	3772.84	29.52	0.000
Residual	440	6160.67	48.19	
Total	539	12780.28		

All factors and interactions were highly significant ($P<0.001$) for Scaup (Table 3). Site by month accounted for 29.52% of the deviance (Fig 6.0) indicating seasonal patterns differing strong between the sites at each lake. Month accounted for 8.16% of the deviance, Figures 5.2e,f show an influx in Scaup abundance during May for both lakes, but is particularly marked on Lake Grasmere. with the remaining interactions attributing less. Site, lake by month, and lake accounted for 7.61%, 3.62% and 2.87% respectively. The overall model fit is 51.78% of the deviance is explained.

(5.2.1.4) Paradise Shelduck

(a)Lake Pearson. Paradise Shelducks were present on Lake Pearson in consistently low abundances (Fig 5.2g) throughout the research period. Maximum abundance occurred in May.

(b)Lake Grasmere. Paradise Shelduck numbers were low at Lake Grasmere for most of the year (Fig 5.2h). A huge influx of birds arrived on Lake Grasmere during January.

(c) Analysis

Table 4. Bird abundance analysis of Deviance Table for Paradise Shelduck

Effect	df	Deviance	%Deviance	Pr(Chi)
Lake	1	2149.28	12.78	0.000
Month	9	7881.37	46.89	0.000
Site in Lake	8	2436.09	14.49	0.000
Lake by Month	9	1641.27	9.76	0.000
Site in Lake by Month	72	435.0	2.58	0.000
Residual	440	2263.82	13.46	
Total	539	16806.85		

All factors and interactions were highly significant ($P<0.001$)for Paradise Shelduck (Table 4). Month explains 46.8% of the deviance for Paradise Shelduck. This factor alone is responsible for just under half of the total deviance. Fig. 5.2h demonstrates the extremely large abundance of Paradise Shelduck on Lake Grasmere in January. It is significantly greater than abundances recorded for the remainder of the research period. Site accounts for 14.49% of the deviance while 12.78% of the deviance is explained by lake. Lake by month explains 9.76% of the deviance. The overall model fit is very high with 86.50% of the deviance explained.

(5.2.1.5) Mallard Duck.

(a) Lake Pearson. Mallard Ducks fluctuated in number on Lake Pearson throughout the research period (Fig 5.3a). Mallard abundances were low compared with other species such as Canada Geese and Black Swan. Mallards decreased in numbers from March to May, increasing again during June. A significant decrease occurred in August, with numbers rising in September and gradually decreasing again over the next three months.

(b) Lake Grasmere

Mallard Duck numbers showed no strong pattern in abundance throughout the research period on Lake Grasmere (Fig 5.3b). Maximum abundance occurred in March and minimum abundance was recorded in December.

(c) Analysis

Table 5. Bird abundance analysis of Deviance Table for Mallard Duck

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	0.0165	1.87	0.898
Month	9	108.33	12.30	0.000
Site in Lake	8	135.85	15.46	0.000
Lake by Month	9	23.75	2.70	0.005
Site in Lake by Month	72	183.46	20.88	0.000
Residual	440	427.00	48.61	
Total	539	878.43		

Lake was not significant. Month, site and site by month were highly significant ($P<0.001$) and lake by month were significant at the $0.01>P>0.001$ level (for Mallard Duck) (Table 5). Site by month accounted for 20.80% of the deviance. Site in lake accounted for 15.46% of the deviance. Month accounted for 12.40% of the deviance. Seasonal variation of abundance was apparent for both lakes (Figs 5.3a,b) although without any simple trend. The overall model fit was 53.21% of the deviance explained.

(5.2.1.6) Grey Duck

(a) Lake Pearson The Lake Pearson populations of Grey Duck fluctuated throughout the research period. Seasonal variation in abundance was apparent showing a cosine-like trend when compared to Mallard duck. Grey Duck abundance increased (Fig 5.3c) sharply during early winter peaking in June. Abundances dropped over spring with minimum numbers recorded in October, and then gradually increasing again as summer progressed. The Grey Duck population of Lake Pearson was greater than the Mallard Duck population.

(b) Lake Grasmere Grey Ducks demonstrated consistently low abundances throughout the research period on Lake Grasmere (Fig 5.3d). Grey Duck abundance was lower than at Lake Pearson. Maximum Grey Duck abundance on Lake Grasmere was recorded in March. Bird numbers decreased over the winter months with minimum abundance occurring during June, increasing again with the onset of spring.

(c) Analysis

Table 6. Bird abundance analysis of Deviance Table for Grey Duck

Effect	df	Deviance	%Deviance	Pr(Chi)
Lake	1	65.42	2.16	6.661
Month	9	210.71	6.96	0.000
Site in Lake	8	361.35	11.93	0.000
Lake by month	9	204.78	6.76	0.000
Site in Lake by Month	72	614.13	20.29	0.000
Residual	440	1570.24	51.88	
Total	539	3026.66		

With similarities to the Mallard Duck, Grey Duck abundance was significantly affected by four factors and interactions: month, site, lake by month and site by month. Lake was not significant (Table 6). Site by month explained 20.29% of the deviance. Site accounted for 11.93% of the deviance and month 6.96% of the deviance. Lake by month accounted for 6.76% of the deviance. The overall model fit is high, with 66.79% of the deviance explained.

(5.2.1.7) Mallard/Grey Duck Hybrid

(a) Lake Pearson Hybrids were only recorded present on Lake Pearson from March to August. No hybrids were recorded from September through to January. Maximum and minimum abundance occurred in April and March respectively.

(b) Lake Grasmere

Hybrids were only recorded on Lake Grasmere from April to September. Maximum and minimum abundance occurred in September and April respectively.

(c) Analysis

Table 7. Bird abundance analysis of Deviance Table Grey/Mallard Duck Hybrid

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	1.06	0.07	0.302
Month	9	352.73	24.38	0.000
Site in Lake	8	296.38	20.49	0.000
Lake by Month	9	68.09	4.70	0.000
Site in Lake by Month	72	5.84	14.92	0.000
Residual	440	512.24	35.41	
Total	539	1446.37		

Lake did not significantly affect Mallard/Grey Duck Hybrid abundance

(Table 7). The remaining four factors and interactions were significant, with month accounting for 24.30% of the deviance. Figs 5.3e,f show the winter versus summer variation in hybrid abundance. Site was an important factor explaining 20.40% of the deviance. Site by month accounted for 14.90% of the deviance. Lake by month only explained 4.70% of the deviance. The overall model fit was high with 64.56% of the deviance explained.

(5.2.1.8) Shoveler

(a) Lake Pearson No Shoveler were recorded present on Lake Pearson throughout the entire research period (Fig 5.3g).

(b) Lake Grasmere Shoveler were recorded on Lake Grasmere from October through to January of the research period (Fig 5.3h). Greatest abundance occurred in December.

(5.2.1.9) Farmyard/Feral Goose

(a) Lake Pearson Feral Goose were not recorded on Lake Pearson throughout the research period.

(b) Lake Grasmere One Feral Goose was present on Lake Grasmere from October to January. It was observed most often during December and January.

(5.2.2) Grebes

(5.2.2.1) Crested Grebe

(a) Lake Pearson Grebe abundances fluctuated throughout the research period (Fig 5.4c,) demonstrating seasonal variation patterns. Numbers decreased during the winter to a minimum in June. Abundance increased again with the onset of spring in August. Grebe abundance dropped slightly during November but increased to a maximum in January.

(b) Lake Grasmere Grebes were present in consistently low numbers throughout the research period on Lake Grasmere (Fig5.4d). Seasonal abundance patterns were not as marked those found on Lake Pearson. Maximum and minimum Crested Grebe abundance occurred during March and August respectively.

(c) Analysis

Table 8. Bird abundance analysis of Deviance Table for Crested Grebe

Effect	df	Deviance	%Deviance	Pr(Chi)
Lake	1	253.64	22.56	0.000
Month	9	65.15	5.79	0.000
Site in Lake	8	225.95	20.09	0.000
Lake by Month	9	28.65	2.54	0.000
Site in Lake by Month	72	125.59	11.17	0.000
Residual	440	425.16	37.80	
Total	539	1124.18		

All factors and interactions were highly significant ($P<0.001$) for Crested Grebe (Table 8). Lake accounted for 22.50% of the deviance, due to the Crested Grebe abundance on Lake Pearson being greater than that of Lake Grasmere. Site accounted for 20.09% of the deviance. 11.17% of the deviance was explained by site lake by month. Month and lake by month accounted for 5.79% and 2.54% of the deviance respectively. The overall model fit was 62.15% of the deviance explained.

(5.2.3) Shags

(5.2.3.1) Black Shag

(a) Lake Pearson

Black Shag were not consistently present on Lake Pearson for the majority of the research period but demonstrated seasonal patterns through fluctuations in abundance. Maximum abundance occurred in May with reduced abundances during October and November. No Black Shags were recorded during the months of April and December.

(b) Lake Grasmere

Black Shag abundance was lower and more consistent throughout the research period at Lake Grasmere than Lake Pearson. Maximum abundance occurred in January. No birds were recorded during the period September to November on Lake Grasmere.

(c) Black Shag

Table 9. Bird abundance analysis of Deviance Table for Black Shag

Effect	df	Deviance	%Deviance	Pr(Chi)
Lake	1	5.85	1.50	0.015
Month	9	58.25	14.98	0.000
Site in Lake	8	22.39	5.76	0.004
Lake by Month	9	31.20	8.02	0.000
Site in Lake by Month	72	87.24	22.44	0.106
Residual	440	183.83	47.28	
Total	539	388.78		

Three of the five factors were significant for the Black Shag (Table 9). Lake and site in lake by month were highly significant ($P<0.001$) and explained 14.98% and 8.02% of the deviance respectively. Both Figures 5.4e,f show high abundances of Black Shags during May and June. Site within lake was significant to the $0.01>P>0.001$ level. The overall model fit was

52.70% of the deviance explained.

(5.2.3.2) Little Shag

(a) Lake Pearson The abundance of Little Shags on Lake Pearson was highly variable between months. Maximum abundance was recorded in March (Fig 5.4g) fluctuating to a minimum level. No shags were recorded from November to January.

(b) Lake Grasmere

Little Shag abundances were considerably low when present at Lake Grasmere (Fig 5.4h) than at Lake Pearson. Maximum abundance was recorded in April. Little Shags were absent from the lake between September and December.

(c) Analysis

Table 10. Bird abundance analysis of Deviance Table for Little Shag

Effect	df	Deviance	%Deviance	Pr(Chi)
Lake	1	120.04	15.22	0.000
Month	9	203.6	25.83	0.000
Site in Lake	8	55.25	7.01	0.000
Lake by Month	9	12.39	1.57	0.191
Site in Lake by Month	72	136.25	17.28	0.000
Residual	440	260.70	33.07	
Total	539	788.27		

Four factors and interactions produced highly significant results P<00.1 for the Little Shag (Table 10). Lake by Month was not significant. Month accounted for 25.83% of the deviance, reflecting the autumn versus spring seasonability of Little Shags at both lakes (Fig 5.4g,f). A marked difference in abundance between the two lakes (Fig 5.4g,f) leads to lake accounting for 15.22% of the deviance. Site by month accounted for 17.28%

of the deviance. Site accounted for 7.01% of the deviance. The overall model fit was 66.91% of the deviance explained.

(5.2.4) Gulls and Terns

(5.2.4.1) Black-backed Gull

(a) Lake Pearson Black backed Gull abundance fluctuated throughout the research period (Fig 5.6c) occurrence was most consistent during the winter but maximum abundance occurred in January. Gulls were absent from the lake during March, April and November.

(b) Lake Grasmere Black-backed Gulls were present inconsistently at Lake Grasmere throughout the research period (Fig 5.6d). Maximum abundance occurred in September with gulls recorded in August, November and January. They were absent from the lake during the remaining months.

(c) Analysis

Table 11. Bird Abundance Analysis of Deviance Table for Black-backed Gull

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	67.27	11.91	0.000
Month	9	112.82	19.9	0.000
Site in Lake	8	106.83	18.92	0.000
Lake by Month	9	17.08	3.02	0.047
Site in Lake by Month	72	71.03	12.58	0.510
Residual	440	189.54	33.57	
Total	539	564.59		

Four effects produced significant results for Black-backed Gull (Table 11). Site in lake by month was not significant. Lake by month was weakly significant (0.05>P>0.01) and only accounted for 3.02% of the deviance. Month was highly significant (P<0.001) and accounted for 19.9% of the deviance. This can be seen in Fig 5.6c where high abundances occurred in January in Lake Pearson. Site was highly significant to the $P<0.001$ level and accounted for 18.92% of the deviance. Lake explained 11.91% of the deviance. The overall model fit was 66.33% of the deviance explained.

(5.2.4.2) Black-fronted Tern

(a) Lake Pearson Black-fronted Terns occurred at Lake Pearson in low abundances during late winter, spring and summer (Fig 5.6e). Greatest abundance occurred in November. Terns were absent from Lake Pearson from March to June and during the month of October.

(b) Lake Grasmere Black-fronted Terns were not recorded at Lake Grasmere during the research period.

(5.2.5) Waders

(5.2.5.1) White faced Heron

(a) Lake Pearson White-faced Heron abundances fluctuated throughout the research period on Lake Pearson (Fig 5.5a). Maximum abundance was recorded during March with the herons being absent from the lake between May and September. Consistent abundances were recorded during spring and summer.

(b) Lake Grasmere

White faced Heron were predominantly absent from Lake Grasmere (Fig 5.5b). They were recorded in very low abundances during January.

(5.2.5.2) Spur-winged Plover

(a) Lake Pearson Spur-winged Plover were present throughout the research period at Lake Pearson. Patterns of seasonal variation and a cosine-like trend can be clearly seen in Fig 5.5c. Maximum and minimum abundance occurred in May and August respectively.

(b) Lake Grasmere

Spur-winged plover were rare visitors to Lake Grasmere (Fig 5.5d). They were only recorded in three months (September, November and January) with the greatest abundance occurring in September.

(5.2.5.3) Pied Stilt

(a) Lake Pearson Pied Stilt abundance on Lake Pearson shows a cosine trend associated with variability of abundance between seasons (Fig 5.5e). Maximum abundance occurred in December with stilts being absent from the lake in April, June and August.

(b) Lake Grasmere In contrast to the resident population at Lake Pearson, Pied Stilts were rare visitors to Lake Grasmere (Fig 5.5f). They were only recorded during two months, April and January, with maximum abundance occurring in the latter. No breeding occurred at Lake Grasmere.

(5.2.5.4) Banded Dotterel

(a) Lake Pearson

Banded dotterels were only recorded during the summer months at Lake Pearson being absent from the lake for the majority of the year. Abundances were consistently low, with maximum levels recorded in January.

(b) Lake Grasmere No banded dotterals were recorded at Lake Grasmere during the research period.

(5.2.5.5) South Island Pied Oystercatcher

(a) Lake Pearson South Island Pied Oystercatchers were only present at Lake Pearson from September to January (Fig 5.6a). During this period numbers fluctuated although abundances were always low. Greatest abundance occurred in October.

(b) Lake Grasmere South Island Pied Oystercatchers were only present on Lake Grasmere during the month of March and at very low abundances (Fig 5.6b). They were absent from Lake Grasmere for the remainder of the research period.

(5.2.6) Other

(5.2.6.1) Pipit

(a) Lake Pearson Pipits were recorded in very low numbers at Lake Pearson during the months of May, November and December. Maximum abundance occurred in May and December. Pipits were absent from Lake Pearson for the remainder of the research period.

(b) Lake Grasmere Pipits were not recorded at Lake Grasmere.

(5.2.6.2) Harrier Hawk

(a) Lake Pearson

Harrier Hawks were only recorded during three months of the research period with consistently low abundances (Fig 5.7a). Greatest abundance occurred in June.

(b) Lake Grasmere

Harrier hawks were recorded during the months of August and October in equal abundances (Fig 5.7b). Hawks were absent for the remainder of the research period.

(5.2.6.3) Australian Magpie

(a) Lake Pearson Australian magpies were recorded during three months of the research period in very low abundances at Lake Pearson (Fig 5.7a). Greatest abundance occurred in June.

(b) Lake Grasmere No Australian magpies were recorded at Lake Grasmere during the research period.

5.3 FEEDING ANALYSIS

Statistical analysis was attempted for all bird species as above. Again species with very low and infrequent abundances could not be fitted to a model. These included species such as Grey Duck, Grey/Mallard Duck Hybrid, Shoveler, Feral Goose, Pied Stilt, Spur-winged Plover, South Island Pied Oystercatcher, Black fronted Tern, Black backed Gull, White faced Heron, Harrier Hawk, Pipit and Australian Magpie. Bird species that did fit the model are presented below.

(5.3.1) Canada Goose

Table 12. Feeding Analysis of Deviance Table for Canada Goose

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	0.4354	0.32	0.509
Month	9	15.70	11.61	0.073
Site in Lake	2	2.71	2.0	0.257
Lake by Month	8	14.39	10.6	0.072
Site in Lake by Month	15	11.6	8.6	0.703
Residual	123	90.28	66.7	
Total	158	135.21		

Feeding behaviour in Canada Geese was not significantly affected by any factor or interaction (Table 12).

(5.3.2) Black Swan

Table 13. Feeding Analysis of Deviance Table for Black Swan

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	50.74	20.37	0.000
Month	9	15.02	6.03	0.090
Site in Lake	2	0.97	0.39	0.613
Lake by Month	8	25.97	10.42	0.001
Site in Lake by Month	15	19.76	7.93	0.180
Residual	212	136.59	54.83	
Total	247	249.07		

Black Swan feeding behaviour was significantly affected by lake (P<0.001) (Table 13). Lake explains 20.37% of the deviance. Lake by month is also highly significant at the (P<0.001) level. This means that the seasonal patterns in feeding behaviour differ between lakes. Month, site and site by month are not significant. The overall model fit is 45.14% explained by the deviance.

(5.3.3) Scaup

Table 14. Feeding Analysis of Deviance Table for Scaup

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	2.21	0.81	0.136
Month	9	18.96	7.0	0.025
Site in Lake	2	4.42	1.63	0.109
Lake by Month	9	16.49	6.09	0.057
Site in Lake by Month	18	13.03	4.81	0.789
Residual	234	215.52	79.62	
Total	273	270.66		

Scaup feeding behaviour was weakly affected (0.05>P>0.01) by month (Table 14). The remaining four factors and interactions were not significant. The overall model fit was low, with only 20.34% of the deviance explained.

(5.3.4) Mallard Duck

Table 15. Feeding Analysis of Deviance Table for Mallard Duck

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	3.82	3.74	0.050
Month	9	11.61	11.35	0.236
Site in Lake	2	9.37	9.16	0.009
Lake by Month	8	15.74	15.40	0.046
Site in Lake by Month	13	12.59	12.31	0.479
Residual	46	49.07	48.0	
Total	79	102.22		

Mallard Duck feeding behaviour was very weakly affected by site and less weakly affected by the interaction of lake and month ($P<0.01$) (Table 15). Site accounted for 9.16% of the deviance. Lake by month accounted for 15.40% of the deviance. Lake, month and site in lake by month were not significant. The overall model fit is 51.96% of the deviance explained.

(5.3.5) Paradise Shelduck

Table 16. Feeding Analysis of Deviance Table for Paradise Shelduck

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	10.03	6.08	0.001
Month	9	6.36	3.86	0.702
Site in Lake	2	2.27	0.01	0.320
Lake by Month	9	12.31	7.47	0.195
Site in Lake by Month	14	23.95	14.52	0.046
Residual	120	109.90	66.66	
Total	155	164.85		

Paradise Shelduck behaviour was weakly significantly affected by lake and very weakly, the interaction of site and month, which accounted for 6.08% and 14.52% of the deviance respectively (Table 16). Month, site in lake and lake by month factors and interactions were not significant. The overall model fit is low with only 24.47% of the deviance explained.

(5.3.6) Crested Grebe

Table 17. Feeding Analysis of Deviance Table for Crested Grebe

Effects	df	Deviance	%Deviance	Pr(Chi)
Lake	1	1.00	0.51	0.316
Month	9	13.60	7.03	0.137
Site in Lake	2	6.26	3.24	0.043
Lake by Month	9	21.93	11.35	0.009
Site in Lake by Month	15	8.61	4.45	0.896
Residual	153	141.83	73.39	
Total	189	193.26		

Crested Grebe feeding behaviour was weakly significantly affected by lake by month and site (Table 17). These accounted for 11.35 and 3.24% of the deviance respectively. Lake, month and site within lake by month were not significant. The overall model fit was low with only 26.58% of the deviance explained.

5.4 HABITAT USAGE

(5.4.1) Lake Pearson

(5.4.1.1) Order Anseriformes

(i) Feeding Habitats Feeding habitats were slightly variable throughout the year, but some patterns were apparent.

Open water of combined category (unsure whether aquatic vegetation is present or not) and shallow water were prominent and consistent feeding habitats of waterfowl on Lake Pearson (Fig 5.8). This was particularly noticeable during April through to June when bird abundances were high. The use of mudflat as feeding habitat was noticeable during October and during the winter months from May through to August. Flood terraces were utilised more as feeding grounds in November and December.

At times, it was difficult to make the distinction between open and shallow water and in some sites as to whether aquatic vegetation was present or not. Shallow water in this instance is defined as a combined category where aquatic vegetation may or may not be present (see Appendix B for more detailed information).

(ii) Resting Habitats Flood terraces were popular habitats to rest particularly during the months of March, April and June (Fig 5.9). Open water irrespective of aquatic vegetation content was a consistently popular habitat to rest, throughout the research period.

(5.4.1.2) Order Charadriiformes

(a) Waders

(i) Feeding Habitats Feeding habitats of waders remained very consistent throughout the research period (Fig 5.10). Shallow water with aquatic vegetation and lake edges with mud substrate were the most common feeding habitats. Waders did not appear to feed in shallow water wth no aquatic vegetation. Lake edges of gravel substrate were used less by waders. During the winter, lake edges of mud substrate were utilised for feeding. Greatest wader abundance was found on mudflats during the months of March and October. A flood terrace was only used as a feeding ground during November.

(ii)Resting Habitats Waders were not observed resting as often as were waterfowl (Fig 5.11). Resting waders were generally found on lake edges with gravel substrate, followed by shallow water habitats.

<u>Key for Figures 5.8 to 5.28</u> (refer to Appendix B for detailed descriptions of categories)

ow + av	= open water with aquatic vegetation
ow - av	= open water without aquatic vegetation
ow, cd.cty	= open water, combined category (unsure if aquatic vegetation exists)
l.edge	= lake edge
sw + av	= shallow water with aquatic vegetation
sw, cd.cty	= shallow water, combined category (unsure if aquatic vegetation exists)
fld.tce	= flood terrace
l.edm	= lake edge with mud substrate
l.edpe	= lake edge with pebble substrate
ow,fp	= fence post overhanging open water

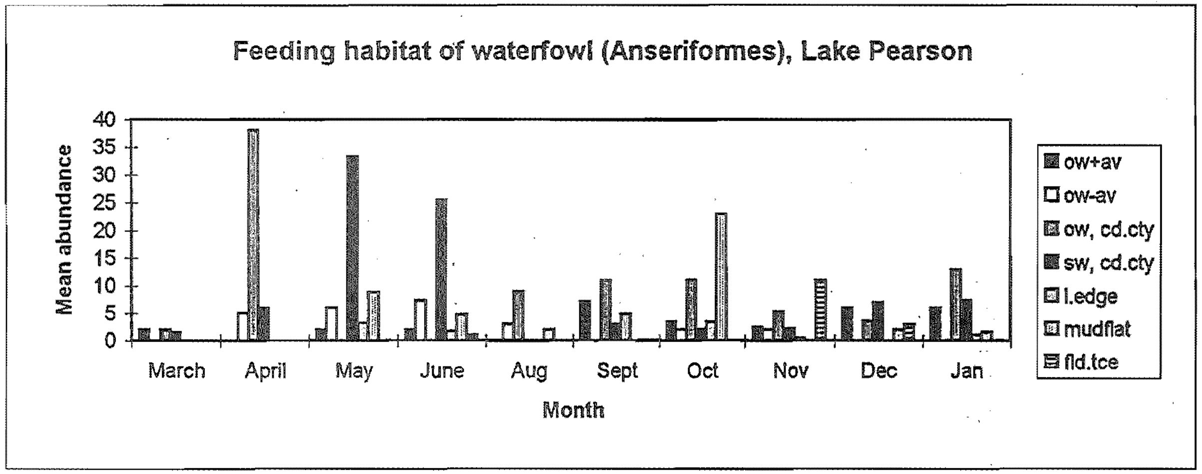


Figure 5.8

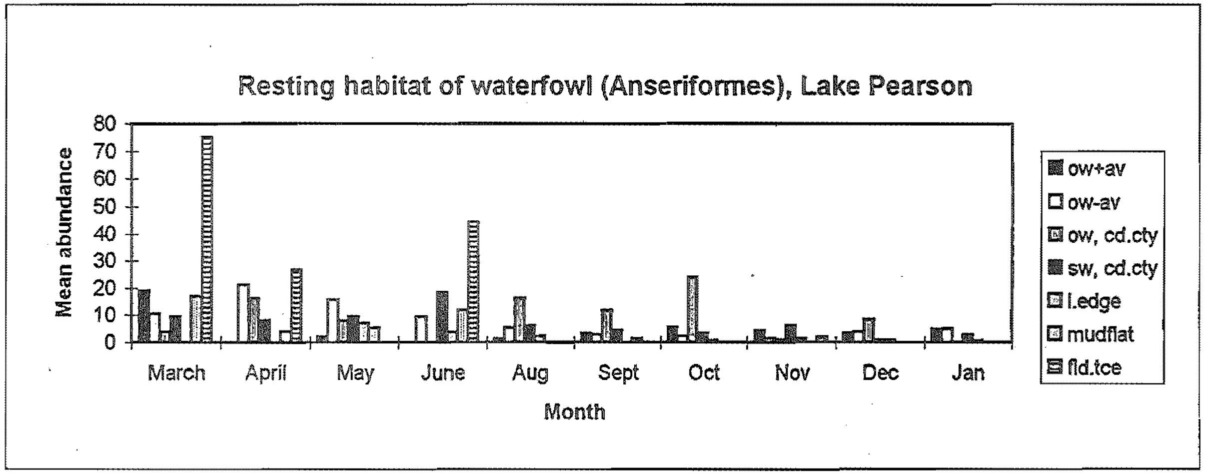


Figure 5.9

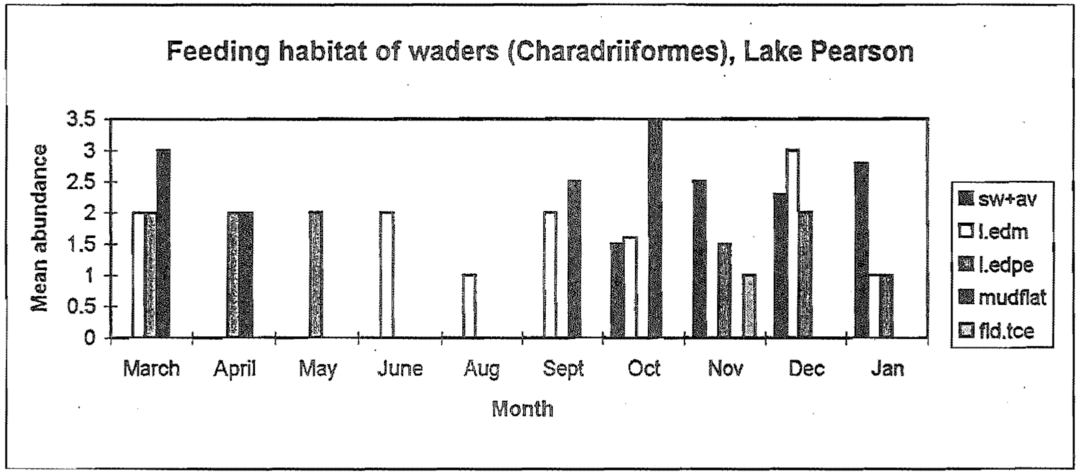


Figure 5.10

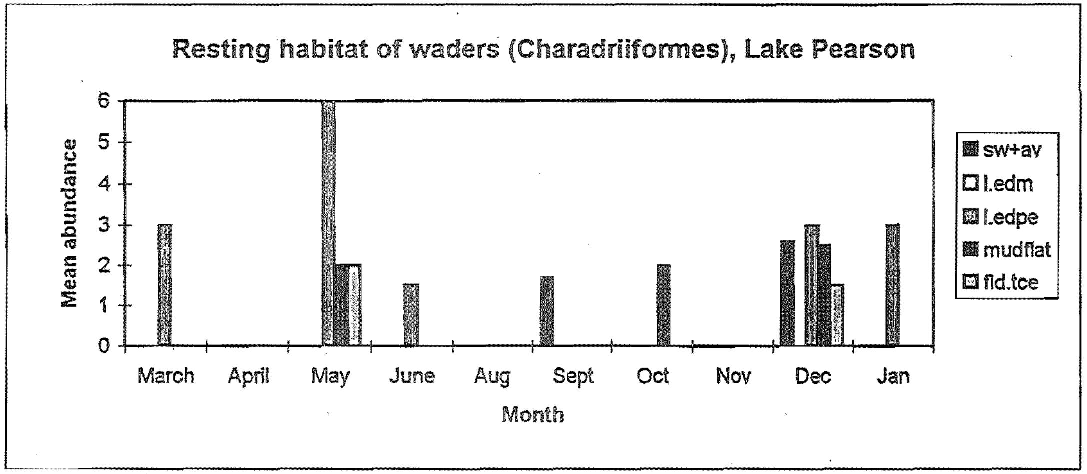


Figure 5.11

(b) Gulls and Terns

(i) Feeding Habitats Gulls and terns fed in open water habitats (Fig 5.12). Greater abundances were found on open water that contained aquatic vegetation.

(ii) Resting Habitats Black-backed gulls rested on open water zones that did not contain aquatic vegetation (Fig 5.13). Terns were not recorded resting within any habitat on Lake Pearson.

(5.4.1.3) Order Pelecaniformes (Shags)

(i) Feeding habitats

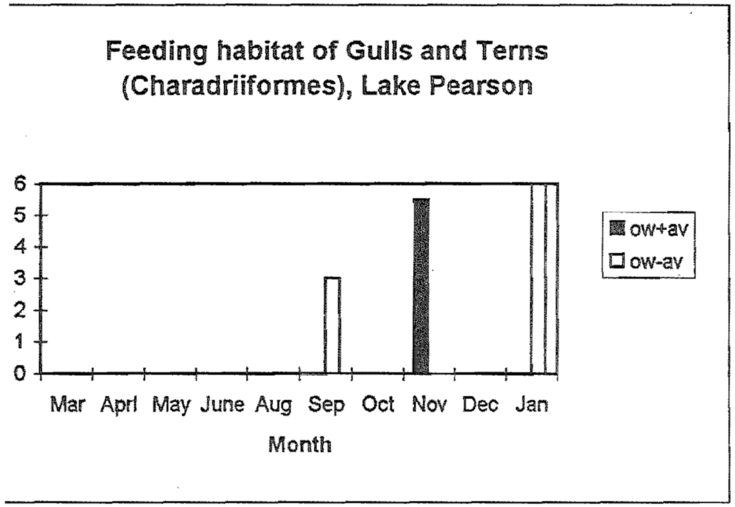
Shags predominantly fed within the open water of Lake Pearson (Fig 5.14). Shags still fed in the open water zone during the winter months May to August, despite the absence of aquatic vegetation. The lake edge was utilised for feeding during March.

(ii) Resting Habitats Fence posts surrounded by open water were consistently popular locations for shags to rest upon (Fig 5.15) after a fishing episode. Shags would often dry their wings while standing on a fence post. The edge of the lake was another habitat where shags would rest, often in communal groups.

(5.4.1.4) Order Podicipediformes (Crested Grebe)

(i) Feeding Habitat Crested Grebe consistently fed within the open water of Lake Pearson (Fig 5.16). Generally fishing occurred within open water that contained aquatic vegetation, but not always.

(ii) Resting habitat Grebes rested within open water (Fig 5.17). The presence or absence of aquatic vegetation did not appear to affect choice of



ɘ 5.12

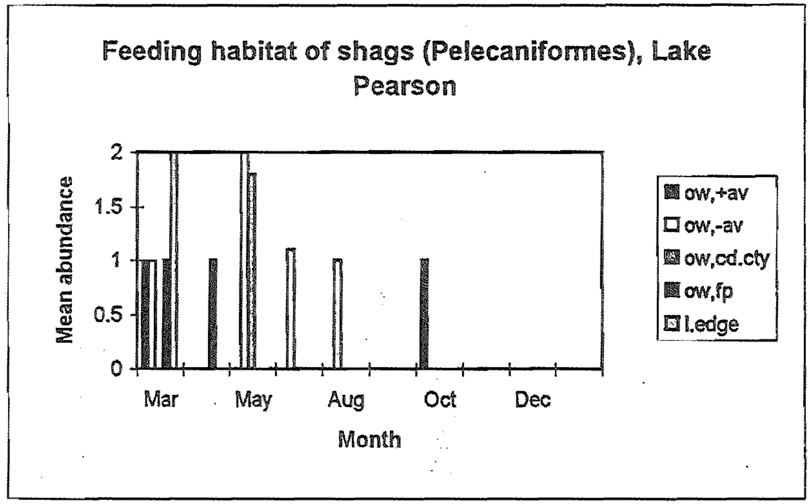
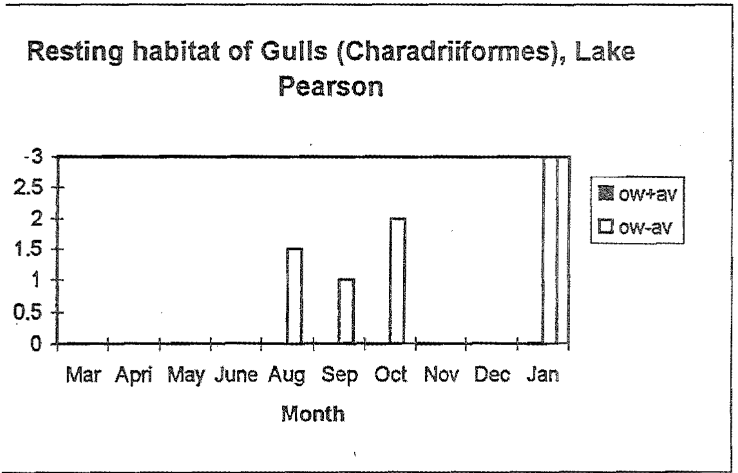


Figure 5.14



e 5.13

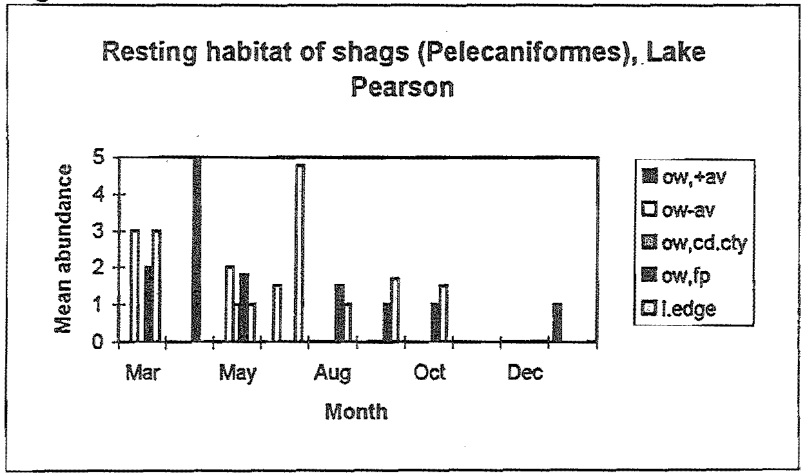


Figure 5.15

resting habitat. Birds often rested in sheltered locations in close proximity to riparian vegetation.

(5.4.1.5) Order Ciconiformes (White-faced Heron)

(i) Feeding habitat White-faced Herons only fed in two habitat types; shallow water with some aquatic vegetation and lake edges with a gravel beach (Fig 5.18). Shallow water with aquatic vegetation was utilised slightly more often than the edge of the lake.

(ii) Resting Habitat White-faced Herons were recorded as resting during March on Lake Pearson (Fig 5.19). Rest occurred within the same habitats as feeding.i.e. shallow water with an aquatic vegetation component and lake edges with a gravel beach.

(5.4.2) Lake Grasmere

(5.4.2.1) Order Anseriformes

(i) Feeding habitat Throughout the research period feeding primarily occurred in open water with aquatic vegetation (Fig 5.20). Feeding within the shallow water regions increased with the onset of winter (from April through to September), the exception being May when no feeding was recorded for the shallow water zone. The bank and swamp were only recorded as being utilised for feeding habitat during October and January.

(ii) Resting Habitat Open water both with and without aquatic vegetation was a popular place to rest for waterfowl on Lake Grasmere, throughout the research period (Fig 5.21). Bank and swamp habitats were also utilised as resting locations, but secondary to open water habitats. Swamp and bank habitats were particularly popular as resting locations during May and

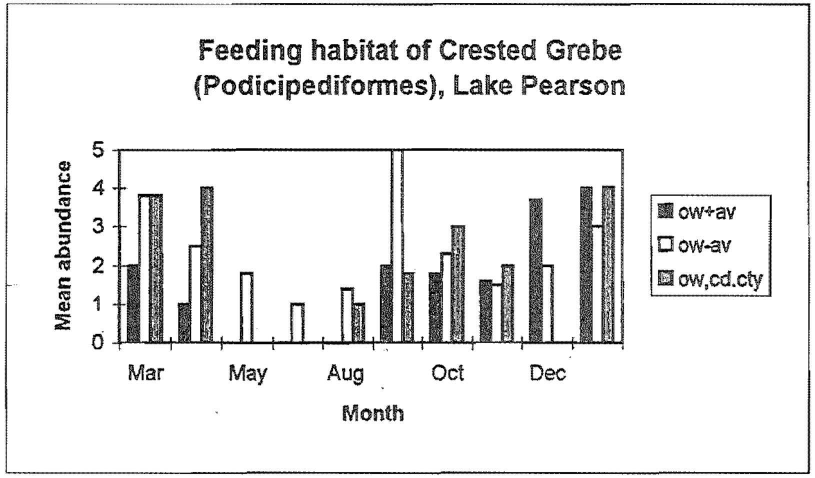


Figure 5.16

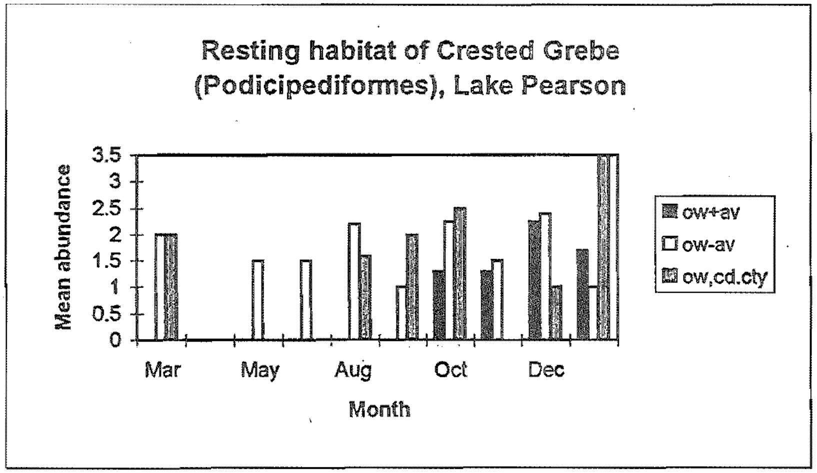


Figure 5.17

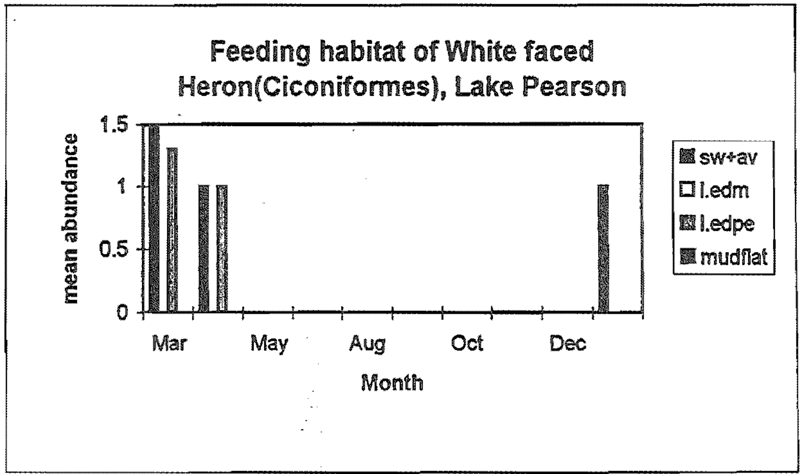


Figure 5.18

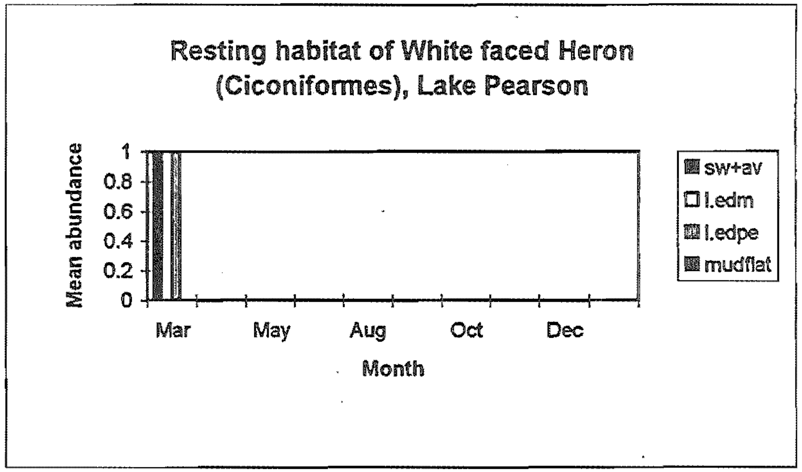


Figure 5.19

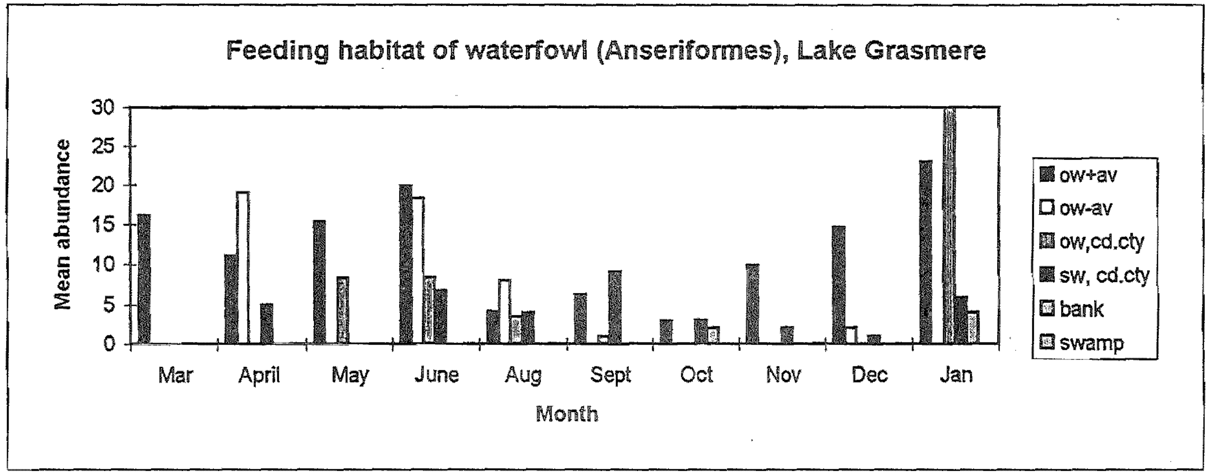


Figure 5.20

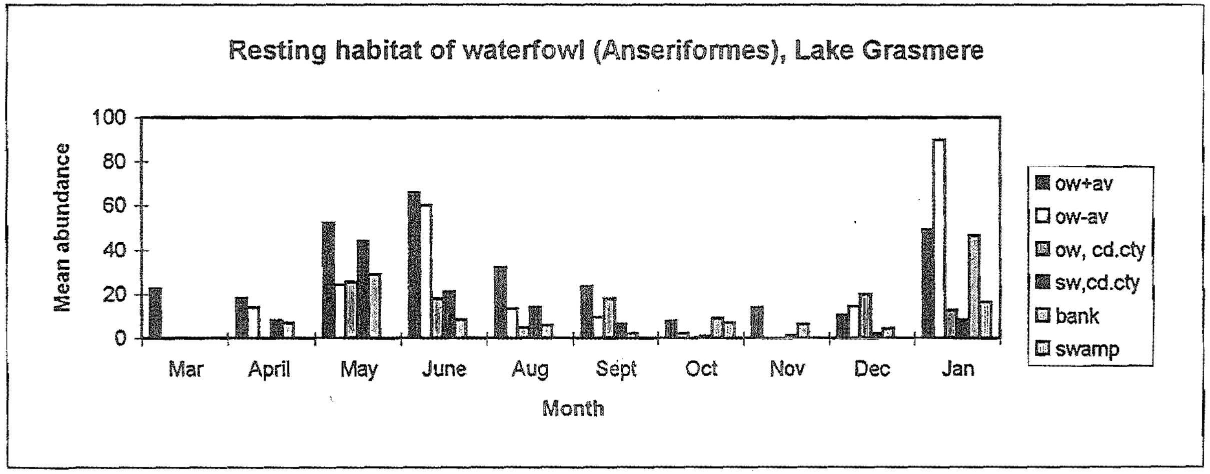


Figure 5.21

January.

(5.4.2.2) Order Charadriiformes

(a) Waders

(i) Feeding Habitat Waders utilised the lake edge, followed by the bank, as feeding grounds on Lake Grasmere when they were recorded in January (Fig 5.22).

(ii) Resting Habitat

Waders were recorded resting on the edge of Lake Grasmere during March and September (Fig 5.23).

(5.4.2.3) Order Pelecaniformes

(i) Feeding Habitat Shags fished within the open water when they were present on Lake Grasmere (Fig 5.30). Open water generally contained aquatic vegetation but not always. The lake edge was not used for feeding.

(ii) Resting habitat

Shags were recorded resting within open water and on fence posts surrounded by water (Fig 5.25).

(5.4.2.4) Order Podicepiformes Crested Grebe

(i) Feeding habitat

Grebes consistently fed within open water regions that generally contained aquatic vegetation (Fig 5.26). However, grebes did sometimes feed in open water zones that contained little or no aquatic vegetation.

(ii) Resting habitat Grebes consistently rested within open water regions that contained aquatic vegetation (Fig 5.27). They were recorded resting in open water with no aquatic vegetation during October.

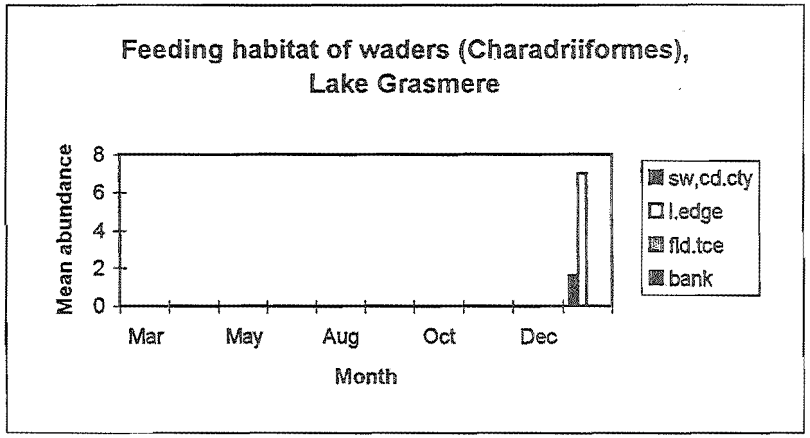


Figure 5.22

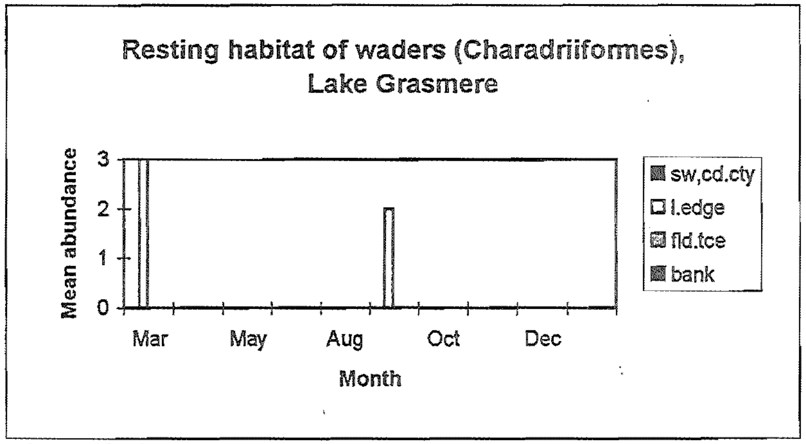


Figure 5.23

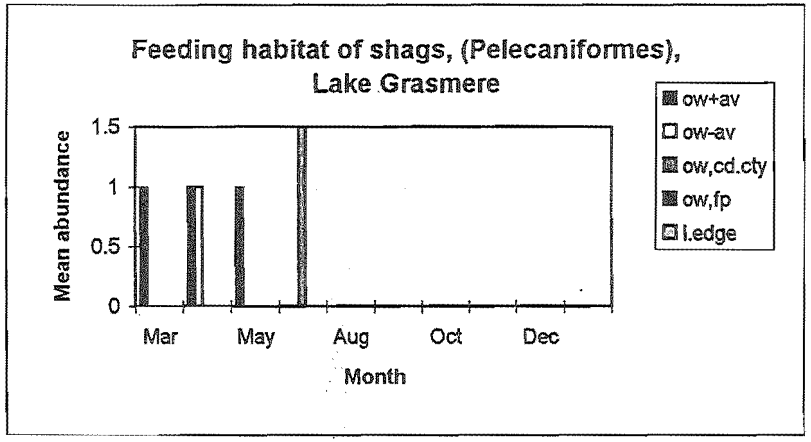


Figure 5.24

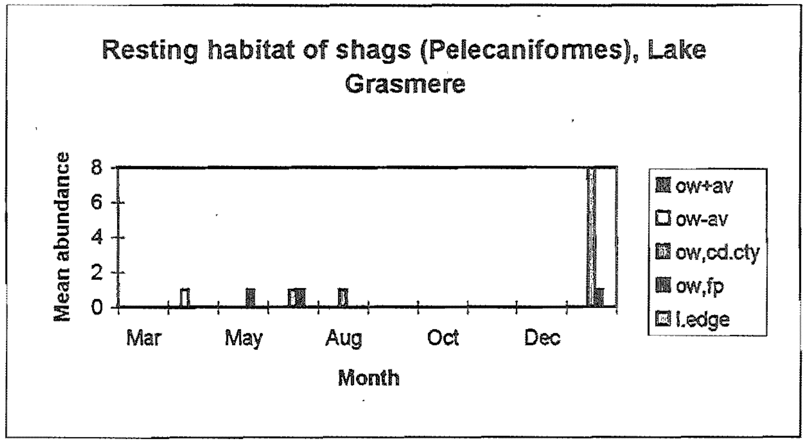


Figure 5.25

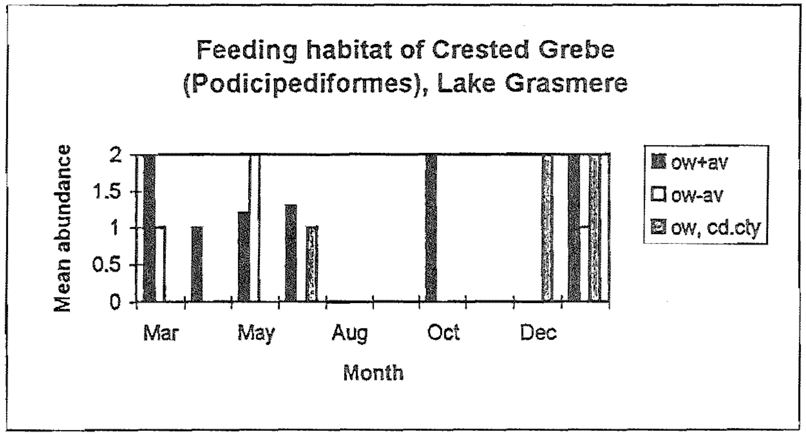


Figure 5.26

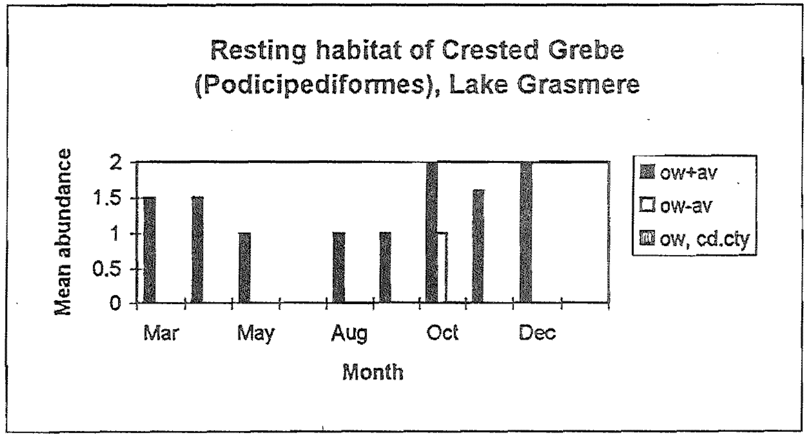


Figure 5.27

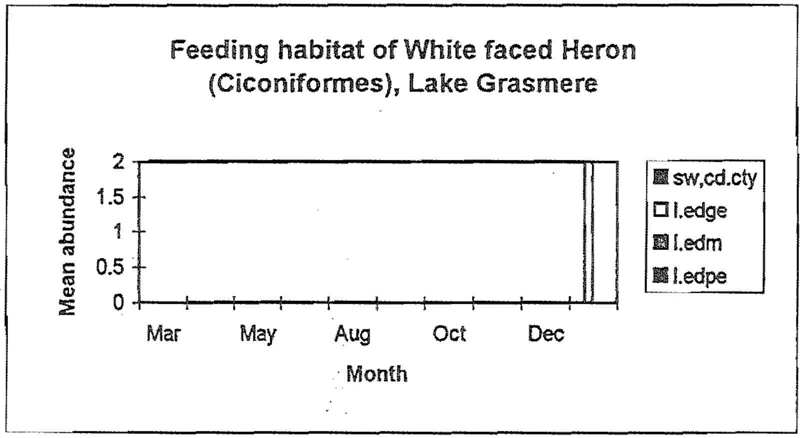


Figure 5.28

(5.4.2.5) Order Ciconiformes White faced Heron

(i) Feeding habitat White-faced Herons were recorded feeding along the lake edge during January (Fig 5.28).

(ii) Resting Habitat No White-faced herons were recorded resting on Lake Grasmere.

5.5 RECREATION

This topic requires further study in its own right, and recreation use data needs to be interpreted with care. Data were predominantly collected during bird sampling times, at sunrise and sunset. Therefore, day trippers (which are an important component of those who undertake recreational use of the lake) are underestimated. People noted using the lakes for recreation purposes during the middle of the day (outside bird sampling periods) are included in the data set. People visit both lakes, predominantly throughout the year but in differing abundances.

(5.5.1) Lake Pearson

The maximum number of people present on Lake Pearson, involved in recreation , occurred during January 1996 (Fig. 5.29). The minimum number of people observed was during June 1995 (no recreational count was carried out during November 1994).

There is a difference in the number of people visiting Lake Pearson during January 1994 and 1995. The inflated numbers observed in January 1995 are attributed to girls participating in watersports associated with the international Girl Guide Jamboree (Plate 40) which was based at Darfield.

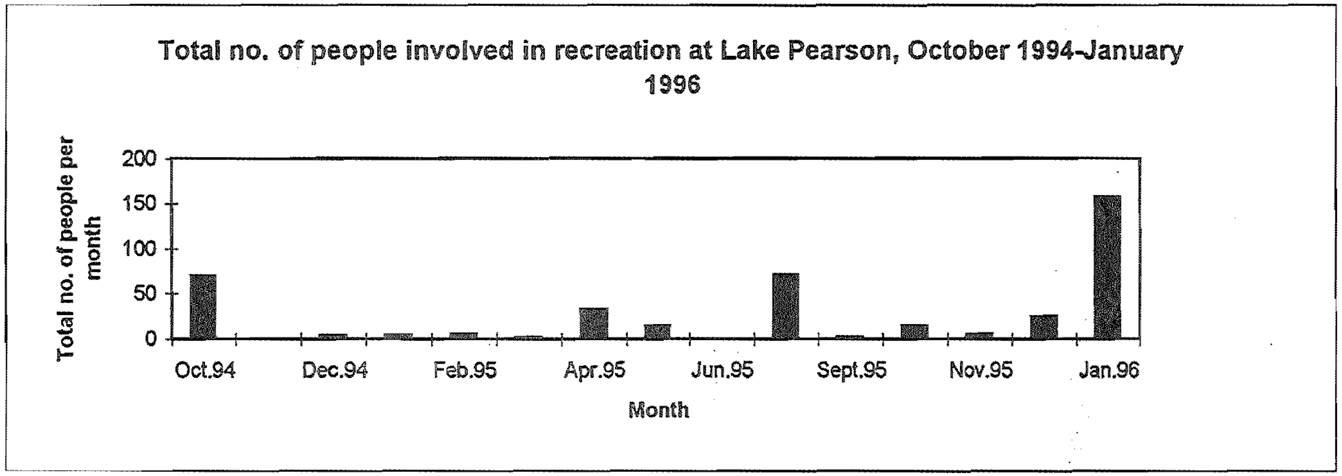


Figure 5.29

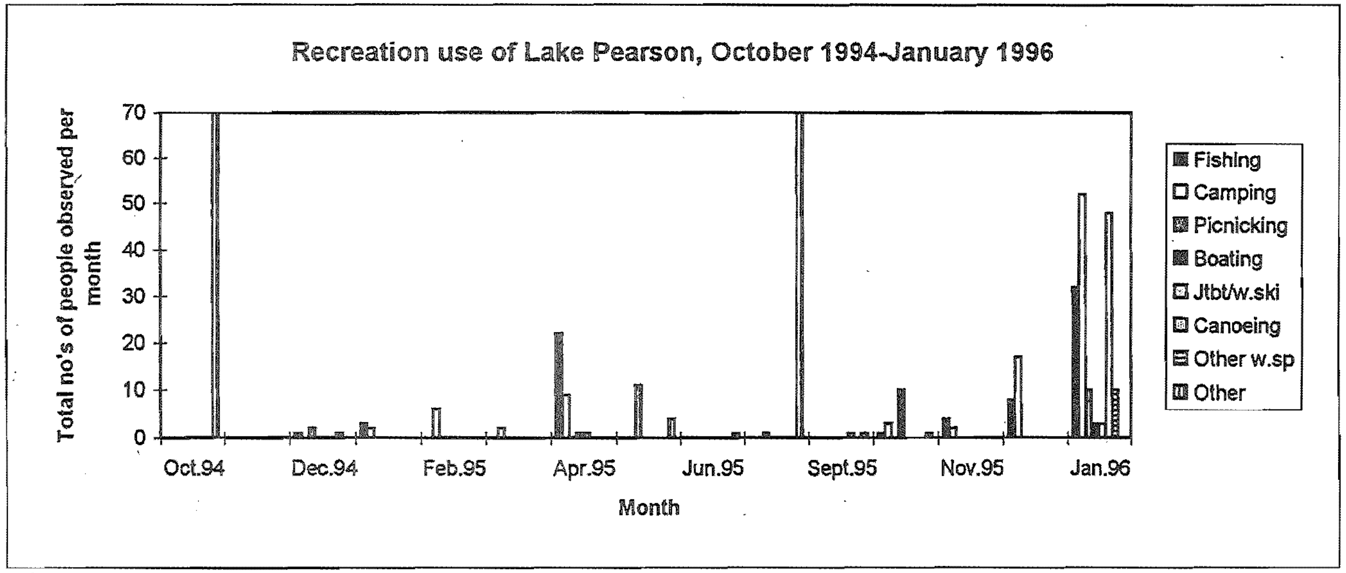


Figure 5.30

The January 1994 figure is possible deflated as observations were not taken during Christmas and New Year when many people are on holiday. The April 1995 recreation count incorporated A.N.Z.A.C Day (April 25th) and it was noted that Lake Pearson had an increased number of visitors during this public holiday.

The recreational use data of October 1994 and August 1995 (Fig. 5.30 note different scale on y-axis from Fig. 5.29, other water sports is abbreviated to other w.sp) included tourist buses which stopped at Lake Pearson to take photographs. I gathered that this was a regular occurrence even though I only observed this twice during the year, probably outside sampling periods.

Recreation activities were most varied during January 1995, when many people were present at Lake Pearson. The two most popular recreation activities consistently participated in at Lake Pearson. The two most popular recreation activities consistently participated in at Lake Pearson were trout fishing (Plate 37) and camping (Plate 39, Fig. 5.30) in that order. These occurred for much of the year with the exception of winter. Between May and August, watersports ceased because of the presence of ice on the lake. Picnicking occurred throughout the year at Lake Pearson. This was partly due to the location of State Highway 73 alongside the lake, which was attractive as a place to rest for people travelling between the two coasts.

Boating occurred spasmodically through the year, during summer and autumn. Jet-boating and water-skiing (Plate 38, Fig. 5.30) occurred predominantly in January but were recorded in April. Canoeing was popular in January too. The category "other" in Fig. 5.30 included any other activity

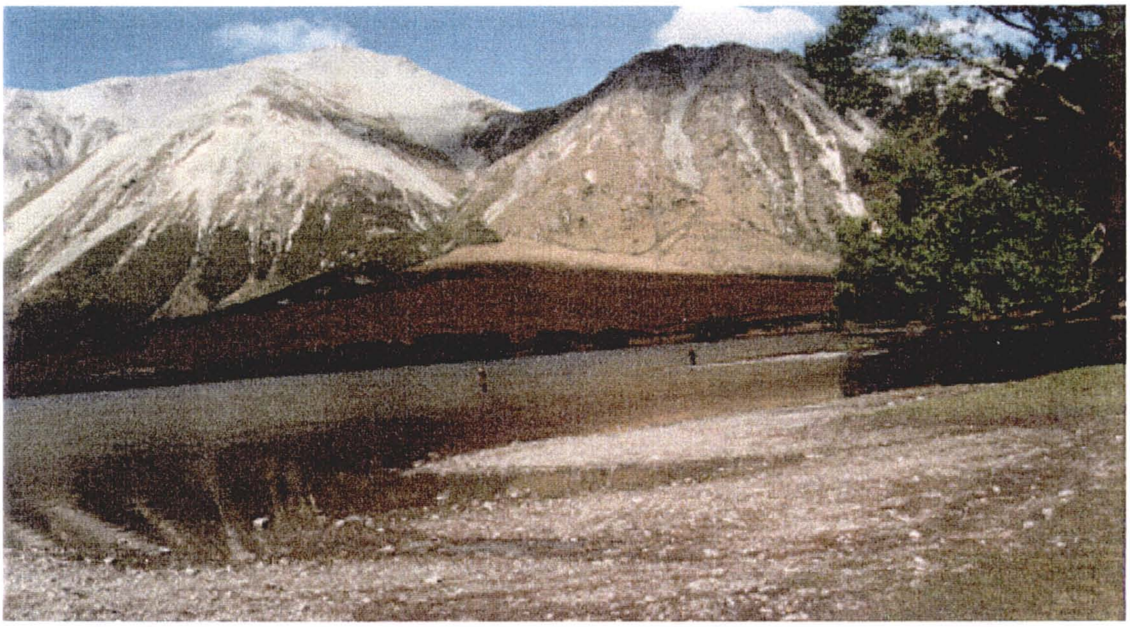


Plate 37: Fishing activities, Site 2, Lake Pearson.

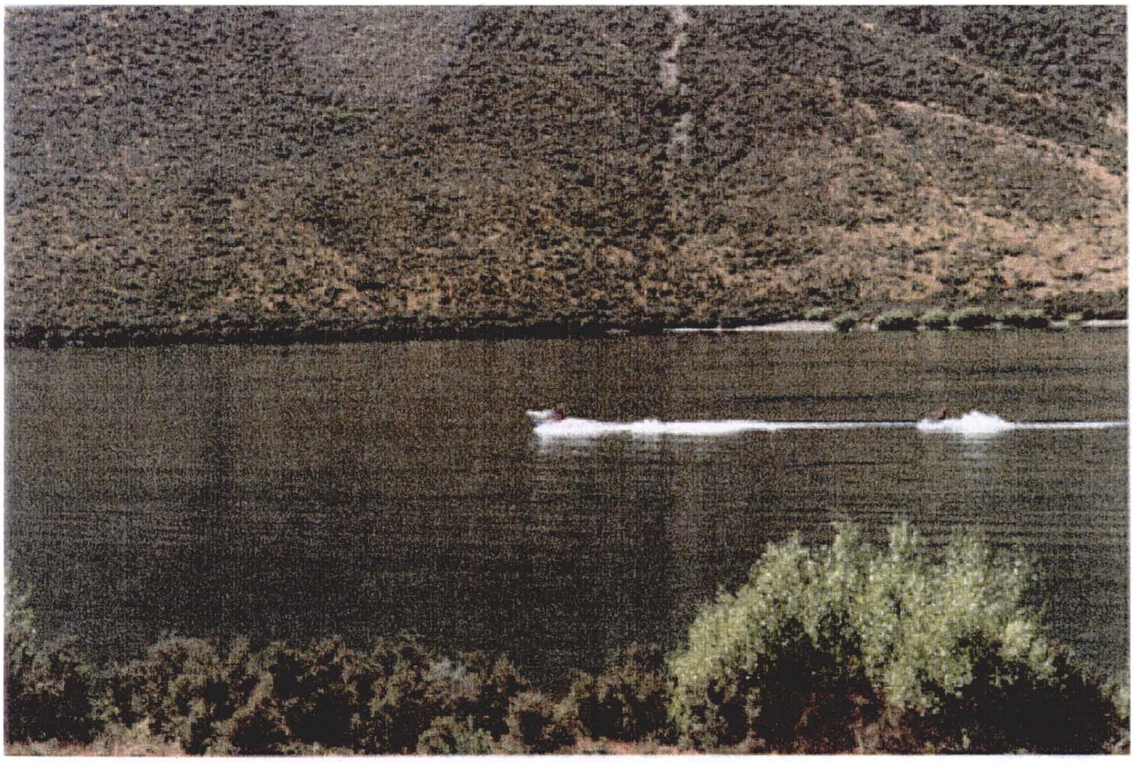


Plate 38: Waterskiing.

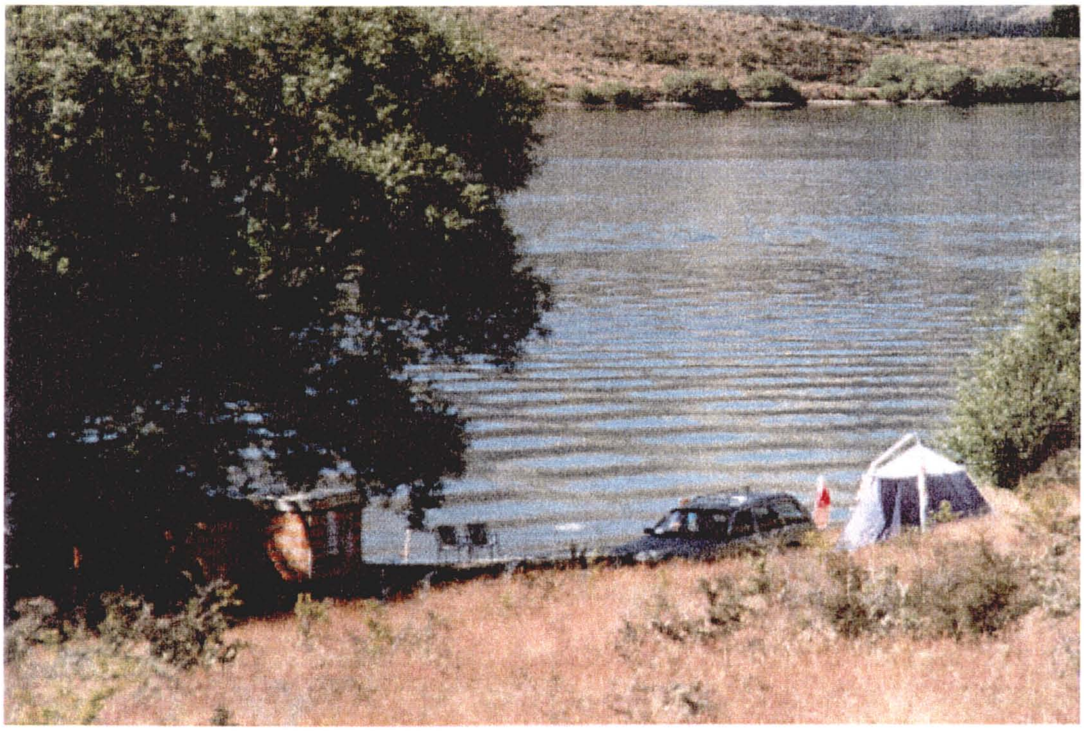


Plate 39: Camping.

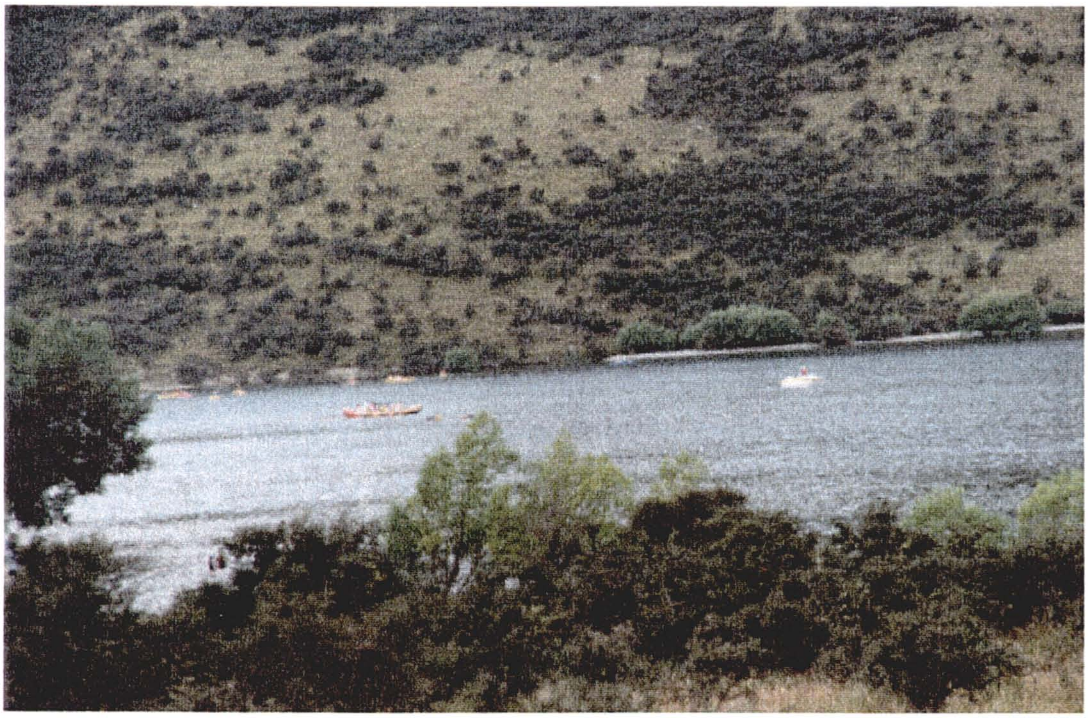


Plate 40: Water sports associated with Girl Guide Jamboree.

that could not be described in the categorised list.

An influx of campers were present on Lake Pearson during December, 1995, due to an international film unit producing an advertisement for Alfa Romeo cars. Lake Pearson and the surrounding countryside was used as a scenic backdrop for the film production.

(5.5.2) Lake Grasmere

People visited Lake Grasmere spasmodically throughout the year and in much reduced abundances (Fig. 5.31) compared to Lake Pearson. People visited the lake regularly over the summer, declining during autumn and winter.

The maximum abundance occurred in February (Fig. 5.31). This was due to the presence of an international film unit producing a television advertisement, on Lake Grasmere. In this film production a wind machine was used for acting purposes in site 4 which frightened all bird species previously present on site 4 to site 1, where waterfowl were clustered together. Events like this sometimes go unheard of and should possibly be regulated and controlled more often. This event aside, visitor numbers at Lake Grasmere are consistent during the summer months.

The dominant recreation activity was fishing; camping was observed during November 1995 (Fig. 5.32). Lake Grasmere does not experience the same varied recreation activities that occur on Lake Pearson. This is partly due to its status as a wildlife refuge, where boating and shooting are prohibited.

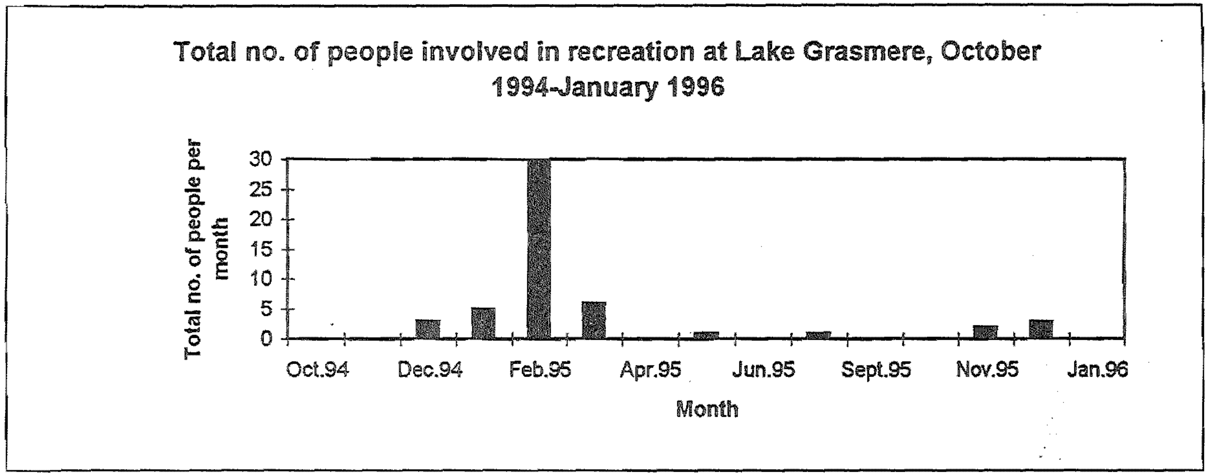


Figure 5.31

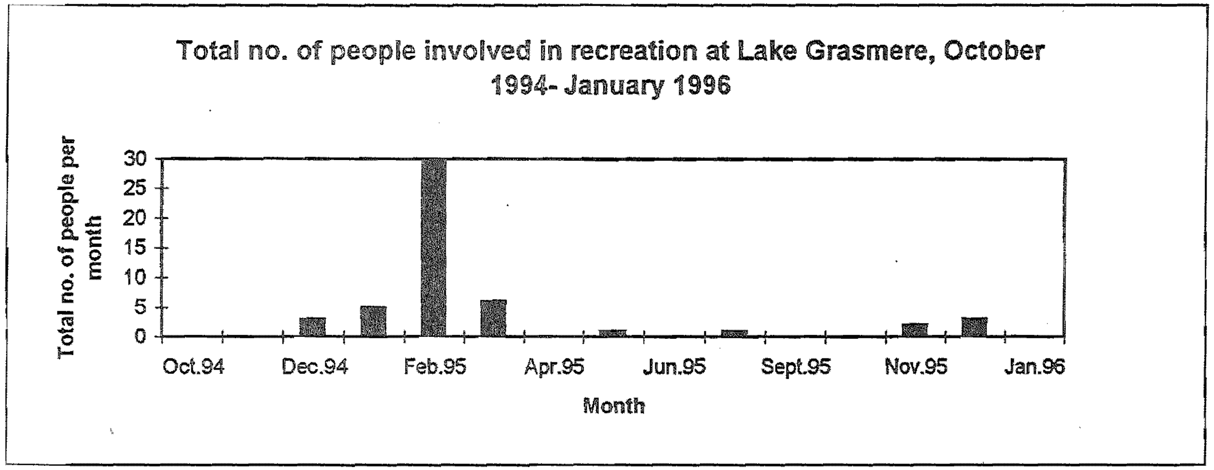


Figure 5.32

CHAPTER SIX

GENERAL DISCUSSION

Studies of high country bird communities in New Zealand have been few. Research has often focused on single species (Pierce,1982; Stokes, 1992; O'Donnell,1979) rather than looking at bird communities as a whole. The bird community studies that have been carried out here have documented and described habitat requirements of various wetland species (Moore et al,1994; Robertson et al. 1982) or seasonal abundance (Stewart & Ward, 1990; Stokes & Grant, 1992).

Overseas, research has been carried out recently on water-bird community structure and their relationship with lake trophic status, and morphological and vegetative characteristics in Florida (Hoyer & Canfield, 1994) and Switzerland (Suter, 1994). There has been little research of similar kind on the bird communities of New Zealand high country lakes as undertaken in this thesis.

Through my research I have attempted to answer the two scientific aims introduced in Chapter 1. These were a) to document and compare species abundance and composition of the bird communities of Lake Grasmere and Pearson over the course of a year, b) attempt to account for differences between the two bird communities.

6.1 COMPARISON OF LAKES PEARSON AND GRASMERE

Lakes Pearson and Grasmere are two nearby high country lakes that show strong differences in their respective bird communities. These differences are a result of the physical and biological structure of the lakes including their component vegetation, both terrestrial and aquatic. The difference in human disturbance levels experienced by the two lakes may play a role in community structure and abundance.

Lake Pearson has a bird community of high species richness but relatively low abundances when compared to Lake Grasmere. Lake Pearson contains a greater number of birds from different orders, but fewer species per order. For example waders, gulls and terns occur in much greater numbers and more regularly on Lake Pearson but are only rare visitors to Lake Grasmere. Lake Grasmere in contrast has a bird community that is almost solely waterfowl. Bird diversity of Lake Grasmere could be considered low even though there may be more species present on Lake Grasmere than Lake Pearson because some orders are poorly represented.

(6.2) SEASONAL PATTERNS AND MIGRATORY MOVEMENTS

(6.2.1) Lake Differences

There are differences in the seasonal variation patterns of species between the two lakes. The majority of waterfowl species present on Lake Pearson exhibit low abundances on a consistent basis throughout the year. Lake Grasmere waterfowl populations, in contrast, fluctuate throughout the year, demonstrating seasonal variation. This can be observed in the Canada

Geese, Black Swan, Paradise Duck and to a lesser extent, Scaup. The Mallard Duck abundance fluctuates throughout the year on both lakes, while the Grey Duck abundance fluctuates on Lake Pearson but is constant on Lake Grasmere.

(6.2.2) Climate and Resource Availability

Season influences the abundance of bird species present on both lakes throughout the year. The degree to which season impacts on bird abundance at a given time is dependent on the species and the weather conditions experienced. Many species migrate to lower altitudes or the coast to escape the high country winter. Scaup typically do not show any strong seasonal migratory movements (Marchant & Higgins, 1990).

The winter of 1995 was particularly harsh with the surfaces of both lakes freezing over. The low temperatures aside, ice formation creates a physical barrier that prevents some species from feeding (Geddes, 1983). Crested Grebes while reluctant fliers (Westerskov, 1974) are forced to fly to ice-free lakes during the winter in order to continue feeding if their resident lake freezes over. In July, 1995 the annual winter count of Crested Grebes was 67 on Lake Forsyth, located on the Canterbury coast, near Lake Ellesmere. This is the largest number of grebes ever recorded on Lake Forsyth, and was indicative of the colder than average weather conditions experienced in the high country (P.Sagar, pers.comm). Grebe movements from iced lakes to ice-free lakes have been documented previously by Westerskov (1974) and O'Donnell (1988). Shags were also forced to move to ice-free lakes in order to continue to feed.

The majority of the wading species were absent from the lakes during the winter due to migration to the coast or North Island. The White-faced Heron and Pied Stilt feed on aquatic vertebrates and invertebrates in shallow water (Carroll, 1967; Marchant & Higgins, 1993; Moon, 1992). Frozen lake surfaces would therefore make feeding extremely difficult for these birds. Spur-winged Plover were the only wading species to remain at Lake Pearson throughout the winter, albeit in very low abundances. Plovers are not so dependent on aquatic invertebrates as part of their diet, as they feed to a large extent on terrestrial insects and grubs (Moon, 1992). Waterfowl such as the dabbling ducks (Grey and Mallard Ducks, and their hybrids) and the Paradise Shelduck are not so dependent on the lake for food during the winter. Their omnivorous diet enables them to feed on a variety of habitats. Fig 5.8 shows that during autumn and winter, the lake edge and mudflat were utilised more for feeding. A frozen lake surface did not necessarily mean that they would starve.

Some waterfowl and shag species exhibited an influx in numbers on the lakes during early winter. Canada Geese abundance on the lakes (particularly Lake Grasmere) increased at this time as they migrated from their breeding grounds in the headwater river valleys to over-winter at the high country lakes. Scaup, particularly those on Lake Grasmere, and Black Swan to a lesser extent increased in number also.

(6.2.3) Breeding Cycles

Low abundances in late winter and early spring can be attributed to birds migrating to breeding grounds elsewhere in the country at locations other than Lakes Pearson and Grasmere. Breeding grounds are chosen for their rich food supplies. High country lakes may not contain enough food for some species such as the Shoveler (Marchant & Higgins, 1990) to enable them to breed there. Shags move to breeding grounds on the coast or in lowland freshwater lakes. Riverbed nesters frequent the shores of the high country lakes once breeding has been completed. Birds that breed on Lakes Pearson and Grasmere may not be counted if they are incubating eggs on nests, hidden from view. This can lead to a perceived reduction in bird abundance which in reality is incorrect.

(6.2.4) Moulting

Abundance levels of particular waterfowl species may greatly increase on lakes during the moulting season, which generally occurs after breeding has been completed. Paradise Shelduck abundances increased sharply during January on Lake Grasmere (Fig 5.2h) when shelducks congregated in large flocks during their annual moult. Birds experiencing moult are temporary flightless and are therefore particularly vulnerable to predation, but by congregating in large numbers at moulting sites this risk is reduced.

(6.3) EXTERNAL FACTORS INFLUENCING DIFFERENCES BETWEEN LAKES

(6.3.1) Lake Trophic Status

Hoyer & Canfield (1994) studied the influence of trophic status, lake morphology and aquatic vegetation on the abundance and species richness of the bird communities of 46 Florida lakes. They concluded that lake trophic generally have high abundance and diversity of invertebrates associated with them (Henriques, 1987, Hoyer & Canfield, 1994) increasing their importance as a food item for waterfowl. Black Swans are aquatic vegetation feeders, and their large abundance observed on Lake Grasmere, can be attributed to the presence of the macrophyte beds. The Black Swan feeding behaviour was significantly affected by lake. McKinnon & Mitchell (1994) correlated winter Black Swan populations with the winter biomass of submerged aquatic macrophytes on seven New Zealand lakes. Lakes with low macrophyte biomass contained low abundances of Black Swans (McKinnon & Mitchell, 1994). Potts & Andrew (1991) in a study of Canada Geese feeding on Grasmere Station, found that geese spent 55% of daytime feeding on aquatic vegetation of Lake Grasmere. Lake Pearson in contrast does not contain aquatic vegetation beds to the degree exhibited in Lake Grasmere. Thus Black Swan abundance was significantly lower than that of Lake Grasmere.

(6.3.3) Lake Morphology

The physical structure of a lake and its component vegetation has a large bearing on whether a species will be present or not. The shoreline of Lake Grasmere is narrow and the scarcity of shallow water areas is not conducive to many wading species as a feeding habitat. Waders and herons utilise gently sloping lake margins and river deltas composed of shingle and mud substrates (Neilson, 1987). Waders prefer to feed in the open, away from tall vegetative cover which overhang step lake margins as observed at Lake Grasmere.

Hoyer & Canfield (1994) suggested that the width of the lake shoreline is more important to wading birds than actual water depth. Shoreline width is related to lake slope which determines the maximum depth waders can forage to. The scarcity of a gently sloping shoreline at Lake Grasmere explains why shallow water feeders such as White-faced Herons, Pied Stilts and Banded Dotterels were rarely or never seen (Marchant & Higgins, 1993). Heglund et al.(1994) found that Pacific Loons (*Gavia pacifica*) and Horned Grebes (*Podiceps auritus*) abundance were positively correlated with increased shoreline length in east central Alaska. Lake Pearson is larger in area than Lake Grasmere, and can accommodate more grebes and their territories.

Willow trees and shrubland line much of the shoreline providing shelter and nesting opportunities. Lake Grasmere in contrast, is smaller in size and does not contain the shrub riparian community, suitable for grebe breeding.

(6.3.4) Site and scale effects

Particular sites within a lake are significantly important to some species. Waders were predominantly seen on Lake Pearson in site 1 and 5. Both sites were very shallow, had wide shorelines and were popular feeding grounds. The site in lake effect in the statistical analysis highlighted how some sites have greater importance to some species over others. Abundance of some species such as the Mallard Duck was not significant for lake but was for site within lake. For these species, small scale patchiness (that of a site) may hold greater importance than that of a larger scale such as a lake. The presence of weed beds and adequate shelter is of greater significance than lake size. Waterfowl would position themselves in sites that were not shaded at Lake Grasmere. Aquatic vegetation beds are likely to be prolific in non-shaded areas. On Lake Pearson, waterfowl were predominantly present in sheltered sites that contained some areas of shallow water.

The site within lake by month interaction accounts for considerable percentage of deviance as it is explaining the interaction of small scale spatial patchiness with monthly patchiness.

(6.3.5) Feeding

The feeding analysis predominantly did not show any clear patterns of feeding behaviour amongst bird species. Feeding behaviour demonstrated random variation throughout the year. Bird feeding behaviour was not determined by the lake, month, site in lake, lake by month and site in lake by month effects and interactions even if bird abundances were. The feeding analysis of Black Swan demonstrated the importance of lake to feeding. Their abundances on Lake Grasmere can be correlated to the reliable food source present within the lake.

(6.3.6) Human influences

(6.3.6.1) Recreation. Recreation plays an important role on Lake Pearson. This lake receives an almost continuous flow of human visitors throughout a year, with the peak period occurring in summer, during the month of January. Species are affected by the human activities in different ways and to different degrees of intensity. Watersports such as waterskiing and jet boating are the most disturbing to bird life with the loud noise, speed and subsequent wave generation and water level fluctuations disrupting and frightening away resident bird life. This recreational activity is particularly disturbing to Crested Grebes. The location of grebe nests and the timing of their nesting period during the peak of summer means that they are particularly vulnerable to recreation-induced disturbance. Common loons (*Gavia immer*) breeding in lakes in Ottawa National Park, Michigan that had a high recreational use and had no restrictions on watercraft, were found to remain off their nests longer than those that bred in restricted-use lakes where wheeled vehicles and motorised boating were banned (Caron & Robinson, 1994). Lake Pearson has a restriction on boat speeds within 200 metres from the shore of 20 kilometres per hour. This speed limit is not always adhered to. Seemingly less intrusive activities such as picnicking and camping can disturb wildlife, particularly during the breeding season when nest desertion may occur. Nests may be trampled by fishermen or other people walking along the lake margin (Stewart & Ward, 1990). Fox et al. (1994) demonstrated that Pochard density was increased on lakes in south central Britain where access to bankside of the lake was restricted. Paradise Shelducks prefer moulting sites that are not used extensively for public recreation (Williams, 1979).

Lake Grasmere, a Wildlife Refuge, does not receive the degree of human recreation disturbance that Lake Pearson receives. Waterfowl flocks are large possibly in part due to the fact that they are not disturbed by motorised boating activities. Fishermen walking along the lake margin may disturb some birds but otherwise the human recreation impact is minimal.

Sewage inputs into lakes have the potential to create major eutrophication problems. Concern has been expressed over inadequate sewage disposal by recreationalists at Lakes Pearson and Grasmere (Selwyn District Council, 1995).

(6.3.7) Agriculture

Of the two lakes, Grasmere receives the greatest impact from agricultural activities. Nutrients enter the lake via runoff from the adjacent fertilised paddocks which, over a long term, will have an effect on nutrient loading. Canada Geese which are intrinsically linked to the aligning paddocks possibly add more nutrients into the lake over the course of a year than simple nutrient runoff from the development. Growth of aquatic macrophytes could possibly be linked to this nutrient loading. This is a problem that might be worthy to be researched further.

Nutrient runoff occurs at Lake Pearson but on a smaller scale. Less of the surrounding catchment experiences fertiliser inputs on a regular basis. The potential remains however, if fertiliser applications on to the surrounding land increased for there to be increased nutrient flow into Lake Pearson.

Eutrophication in the long term, could impact on the bird species, with reduced water clarity which affects grebe and shag feeding, followed by the demise of macrophyte beds due to reduced light penetration levels.

6.4 CONCLUSION:

(6.4.1) Lake Pearson

Lake Pearson is a valuable habitat for many bird species but particularly for the threatened and rare species, the Crested Grebe and Scaup. Despite the human recreation impact on Lake Pearson, grebes still successfully breed on the lake. A decline in the number of grebes has been reported for Lakes Pearson and Grasmere by Westerskov (1971) and the Department of Conservation bird count data base. My Crested Grebe data set appear similar to the values of 1992. The Scaup population has remained stable throughout recent years.

Lake Pearson retains a bird community that is different to that of Lake Grasmere both in abundance and in composition. It is however more at risk from disruption by the recreation activities of people. There is a need to gather current information on numbers of recreational visitors to the lakes and their activities but in a more consistent fashion than was performed in this thesis. There is also room for further study to be undertaken on the actual effects of various disturbance events including tolerance levels of species towards different activities.

(6.4.2) Lake Grasmere

Lake Grasmere retains a bird community that is distinct from that of Lake Pearson. Lake structure restricts the presence of some species such as waders from regularly using the lake. Lake Grasmere plays an important role as a moulting site for waterfowl, particularly Paradise Shelduck. Crested Grebes utilise Lake Grasmere as a food resource.

The biggest threat to Lake Grasmere is from eutrophication effects, particularly with regards to Canada Geese abundance. Agricultural activities have a long term impact on the trophic status.

(6.4.3) Summary

This study has shown interesting comparisons in species abundance and composition on two adjacent, high country lakes, and offers some possible explanations of the differences between the two communities. Further research to clarify some of these possible interactions would be valuable and increase the knowledge of high country aquatic birdlife.

REFERENCES

Burns, C. 1982. New Zealand's vanishing wetlands. *Freshwater Catch, Winter No.15:* 4-5.

Burrows, C.J. (Editor). 1977. *Cass. History and Science in the Cass District, Canterbury, New Zealand.* University of Canterbury.

Caron, J.A and Robinson, W.L. 1994. Responses of breeding common loons to human activity in Upper Michigan.*Hydrobiologia, 279/280:* 431-438.

Carroll, A.L.K. 1967. Foods of the White-faced Heron. *Notornis,Vol.14 (No.1)*

Crawley, M. 1993. GLIM for ecologists. Blackwell Scientific Publications.

Death, R.G. 1991. Environmental stability: its effect on stream benthic communities. Ph.D thesis University of Canterbury.

Dobrowolski, K.A, Halba, R and Nowicki, J. 1976. The role of birds in eutrophication by import and export of trophic substances of various waters. *Limnologica, 10:* 543-549.

Fox, A.D, Jones, T.A, Singleton, R and Agnew, A.D.Q. 1994. Food supply and the effects of recreational disturbance on the abundance and distribution of wintering Pochard on a gravel pit complex in southern Britain. *Hydrobiologia, 279/280:* 253-261.

Gage, M. 1959. On the origin of some lakes in Canterbury. *New Zealand Geographer, 15:* 69-75.

Gage, M. 1977. Glacial geology. In: Burrows, C.J. (ed). 1977. pp. 67-78.

Geddes,D. 1983. Crested Grebes on frozen lakes. *Notornis 30:* 21-22.

Greenland, D.E. 1977. Weather and climate at Cass. In: Burrows, C.J. (ed). 1977. pp. 93-116.

Henriques, P.R. (Editor). 1987. *Aquatic biology and hydroelectric development in New Zealand.* Oxford University Press. Auckland.pp 280.

Hegland, P.J., Jones, J.R., Fredrickson, L.H and Kaiser, M.S. 1994. Use of boreal forested wetlands by Pacific loons (*Garia pacifica* Lawrence) and horned grebes (*Podiceps auntus* L.): Relations with limnological characteristics. *Hydrobiologia, 279/280*: 171-183.

Hoyer, K.V. and Canfield, D.E,Jr. 1994. Bird abundance and species richness on Florida lakes: Influence of trophic status, lake morphology, and aquatic macrophytes. *Hydrobiologia, 297/280*: 107-119.

Hutchinson, D. 1981. A future for lake trout? *Freshwater Catch, Winter No :* 4-5.

Johnson, P.N., and Brooke, P.A. 1989. *Wetland plants in New Zealand.* D.S.I.R. Field Guide, D.S.I.R. Publishing, Wellington, New Zealand.

Kerekes, J.J. 1994. Aquatic birds in the trophic web of lakes. Preface, *Hydrobiologia, 279/280. pviii*

Long, J.L. 1981. *Introduced Birds of the World. The worldwide history, distribution and influence of birds introduced to new environments.* Agricultural Protection Board of Western Australia. David and Charles.

Manny,B.A; Johnson, W.C & Wetzel,R.G. 1994. Nutrient additions by waterfowl to lakes and reservoirs: predicting their effects on productivity and water quality.*Hydrobiologia 279/280:* 121-132.

Marchant, S.and Higgins, P.J. 1990. *Handbook of Australian, New Zealand and Antarctic Birds. Vol.I.* Oxford University Press. Melbourne. pp. 115-124.

McKinnon, S.L. and Mitchell, S.F. 1994. Eutrophication and black swan (*Cygnus atratus* Latham) populations:tests of two simple relationships. *Hydrobiologia*,279/280: 163-170.

Moore,P.J; C.C.Ogle and K.T. Moynihan. 1984. Habitat requirements of wetland birds in the Lake Wairarapa wetlands. New Zealand Wildlife Service, Department of Affairs. *Occasional publication no 5.*

Moon, G. 1992. A field guide to New Zealand birds. Reed Books. pp.256

National Water & Soil Conservation Organisation. 1992. A wetlands guideline. *Water & Soil Management Publication No.8*

National Water & Soil Conservation Organisation. 1983. Environmental Council. Wetlands: a diminishing resource. *Report to the Minister for the Environment. Publication Series 58.*

Neilson, J.M. 1987. Measures to benefit wetland birds. In: Henriques, 1987.

North Canterbury Catchment Board and Regional Water Board. 1986. *Waimakariri River and Catchment Resource Survey, Vol. 1,2 & 3.*

O'Donnell, C.F.J. 1980. The habitat preferences, breeding, feeding behaviour and population of the Southern Crested Grebe (*Podiceps cristatus australis*) on the Ashburton lakes. *B.Sc.(Hons) project. Department of Zoology, University of Canterbury*,Christchurch, NZ.

O'Donnell, C.F.J. 1982. Food and feeding behaviour of Southern Crested Grebes on the Ashburton lakes. *Notornis, 29*:151-156.

O'Donnell, C.F.G. 1988. Southern Crested Grebe on a lowland coastal lake in winter. *Notornis 35:* 75-76.

Ogle, C. 1991. When is dryland wetland? *Forest & Bird, 22(3):*46-49.

Partridge, T. 1982. Types of wetland and their botanical diversity. *Freshwater Catch, Winter No 15:* 5-7.

Pierce, R.J. 1982. A comparative ecological study of pied and black stilts in South Canterbury. *Ph.D thesis. University of Otago*, Dunedin, NZ.

Poole, A.L. and Adams, N.M. 1990. *Trees and Shrubs of New Zealand.* D.S.I.R. Field Guide, D.S.I.R. Publishing, Wellington, New Zealand.

Potts, K.J. and Andrew, J.J. 1991. Canada geese farming on farmland in North Canterbury high country. *Science and Research Series, 39.* Department of Conservation.

Ramsay, A. 1976. Heterotrophic bacteria and their relationship with plankton in a New Zealand freshwater lake. *New Zealand Journal of Marine and Freshwater Research, 10(1)*: 77-90.

Robertson, C.J.R; O'Donnell, C.F.J and Overmars, F.B. 1983. Habitat requirements of wetland birds in the Ahuriri River catchment, New Zealand. N.Z. Wildlife Service, Department of Internal Affairs, Wellington. *Occasional Publication No. 3*

Sagar, P.M. 1981. The distribution and numbers of Crested Grebe in New Zealand 1980. *Notornis 28:* 301-310.

Sagar, P.M. 1982. Indigenous birds. *Freshwater Catch, Winter No 15:* 14-15.

Sagar, P.M. 1995. Comparison of the breeding success of Australasian Crested Grebe (*Podiceps cristatus*) between naturally and artificially fluctuating lakes. Prepared for Lake Coleridge Working Party, E.C.N.Z.

Sagar, P.M and O'Donnell, C.F.J. 1982. Seasonal movements and population of the Southern Crested Grebe in Canterbury. *Notornis 29:* 143-149.

Shanks, A., Glenny, D., Gibson, R., Rosser, K., Roozen, D., Phillipson, S., Steven, J. and Arand, J. 1990. Coleridge, Craigieburn and Cass Ecological Districts. Survey report for the protected natural areas programme. Department of Conservation.

Skagen, S.K. and Knopf, F.L. 1994. Migrating shorebirds and habitat dynamics at a prairie wetland complex. *Wilson Bulletin, 106(1):* 91-105.

StatSci Division. 1995. S-PLUS User's Manual, Version 3.3 for Windows. Mathsoft Inc., Seattle.

Stewart, I.D and Ward, J.C. 1990. Birds of Lake Alexandrina, South Canterbury. *Tane 32:* 137-147.

Stokes, S.J. 1991. Aspects of the breeding biology of New Zealand Scaup (*Aytha novaeseelandiae*). M.Sc. thesis University of Canterbury.

Stokes, S.J and Grant, A. 1992. Birdlife of the lakes of the upper Ashburton catchment and their habitat requirements.*Canterbury Conservancy technical report series* Department of Conservation.

Stout, V.M. 1969. Lakes in the mountain region of Canterbury,New Zealand. *Verhandlungen der Internationalen Vereinigung fur Theoretische und Angewandte Limnologie, 17*: 404-413.

Stout, V.M. 1975. Canterbury, Nelson and Westland lakes. In, *New Zealand Lakes.* V.H. Jolly and J.M.A. Brown. Auckland University Press/Oxford University Press. pp.110-122.

Stout, V.M. 1976. Comparative limnology of several South Island lakes. *New Zealand Limnological Society Newsletter, 12: 43.*

Stout, V.M. 1977. Biology of the fauna of lakes and tarns. In: Burrows, C.J. (ed). pp. 291-31.

Stout, V.M. 1984. Seasonal plankton cycles in two adjacent lakes in the South Island, New Zealand. *Internationale Vereinigung fur Thedretische und Angewandte Limnologie, 22*: 1226.

Suter, W. 1994. Overwintering waterfowl on Swiss lakes: How are abundance and species richness influenced by trophic status and lake morphology? *Hydrobiologia, 279/280*: 1-14.

Williams, M. (Editor). 1990. *Wetlands: A Threatened Landscape.* The Institute of British Geographers. Basil Blackwell Inc.pp.419

Williams, M.J. 1979. The moult gatherings of Paradise Shelduck in the Gisborne-East Coast district. *Notornis 26(4):* 369-390.

Williams, M.J. 1982a. Waterfowl and wetlands-zones of dependence. *Freshwater Catch, Winter No. 15:*12-14.

Williams, M.J. 1982b. Introduction to wetlands: A diminishing resource.*Freshwater Catch, Autumn No. 14:* 9-11.

Westerskov, K.E. 1971. Distribution and numbers of the Crested Grebe *Podiceps cristatus* in Canterbury. *Notornis, 18:* 3-29.

Westerskov, K.E. 1974. The Grebes. *Nature Heritage, 2(18):*489-493.

Wilson, H.D. 1994. *Stewart Island Plants.* The Caxton Press, Christchurch, New Zealand. Second issue. pp.528

Wilson, H.D. and Galloway, T. 1993. *Small-leaved shrubs of New Zealand.* Manuka Press, Christchurch, New Zealand. pp.305

Vant, W.N. 1987. Lake Managers Handbook. Water and Soil No.103. Ministry of Works.

ACKNOWLEDGEMENTS

This thesis would not be in existence if it were not for the support and assistance given by many people. I would like to thank and acknowledge the support of my supervisor Dr.V.M.Stout. It is a great privilege to be her final M.Sc.student and her patience, guidance and assistance with this thesis will not be forgotten. Many thanks to my assistant supervisor Dr.A.D.Sparrow for help in experimental design and statistical analysis and for showing patience with at times a rather trying student.

Dr.V.M.Stout, Dr.A.D.Sparrow and Professor M.J.Winterbourn reviewed the text.

Andrew Grant, Stephen Phillipson and Ken Hughey from the Department of Conservation for the loan of data and project advice.

Paul Sagar, National Institute of Water and Atmospheric Research Ltd for general ornithological advice.

Canterbury Regional Council for the loan of precipitation data at Lake Grasmere and Transit New Zealand for road information.

The Plant and Microbial Sciences Department for the use of the Cass Field Station, without which this thesis would not have been possible.

Thanks to the local runholders of the Cass district, Mr.E.Chapman (Grasmere Station), Mr.J.Westenra (Craigieburn Station) and Mr.B.Turner (Flock Hill Station) for providing access to the lakes and local information. Barry Drummond, New Zealand Railways, provided general assistance at Cass, including the loan of tools to fix bicycle punctures.

Financial assistance is acknowledged from the Laura.J.Clad Scholarship fund.

Thanks to all the technicians within the Zoology and P.A.M.S departments.

Many thanks to all my colleagues within the Zoology and P.A.M.S departments who provided much appreciated support in many ways throughout the span of this thesis. This varied from statistical and computer advice, scanning of photographs and reviewing text to providing assistance in the field and company at Cass, and keeping me sane during the last month of my thesis write-up.

Finally special thanks go to my parents Ian and Norma McClymont and sisters Joanne and Fiona for providing support throughout my University career. Ian, in particular, was my predominant field assistant and constructed the staff gauge at Lake Pearson.

My family provided the bulk of field support and were brilliant assistants in sometimes adverse field conditions. Encouragement was provided from home and in the field with this thesis being a testament to that.

KEY TO BIRD SPECIES ABBREVIATIONS FOR APPENDICES A & D

bandot =Banded Dotteral

bl.ba.Gull/blbagl = Southern Black-backed Gull

bl.bi.Gl= Black-billed Gull

bl.fr.tern= Black -fronted Tern

bl.shag = Black Shag

cangse = Canada Goose

cre.gre = Southern Crested Grebe

E.goose = Farmyard/Feral Goose

falcon = New Zealand Falcon

greydk =Grey Duck

harhk = Harrier Hawk

litshag = Little Shag

mallard= Mallard Duck

m.g.hybd= Mallard/Grey Duck Hybrid

nzpipit = New Zealand Pipit

pardk = Paradise Shelduck

pdstilt = Pied Stilt

scaup = New Zealand Scaup

sipo = South Island Pied Oystercatcher

swplvr = Spur-winged Plover

Un.Duck= Unidentified Duck

w.f.hern = White-faced Heron

Appendix A

BIRD ABUNDANCE DATA-LAKES PEARSON AND GRASMERE

. Data is number of birds observed and counted
in a particular site within the time frame.

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
March	1	Pearson	4	am	630	1	0	0	0	0	0	0	0
March	1	Pearson	2	am	700	3	0	1	2	0	0	0	4
March	1	Pearson	1	am	730	0	0	0	0	0	17	2	0
March	1	Pearson	3	am	800	2	0	0	0	0	0	0	0
March	1	Pearson	5	am	830	4	0	0	0	0	0	0	0
March	2	Pearson	2	pm	1630	2	0	1	1	0	0	0	5
March	2	Pearson	3	pm	1700	0	0	0	0	0	0	0	0
March	2	Pearson	4	pm	1700	5	0	11	0	0	9	0	0
March	2	Pearson	1	pm	1800	0	0	0	0	0	0	0	0
March	2	Pearson	5	pm	1830	6	3	0	1	0	0	0	0
March	3	Pearson	2	am	630	0	0	1	0	0	0	2	2
March	3	Pearson	3	am	700	4	0	0	0	0	0	0	0
March	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
March	3	Pearson	5	am	800	2	0	2	2	0	0	2	0
March	3	Pearson	1	am	830	0	0	0	0	0	0	0	4
March	4	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
March	4	Pearson	2	pm	1700	0	0	7	1	0	0	0	0
March	4	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
March	4	Pearson	5	pm	1750	3	0	0	0	0	48	0	0
March	4	Pearson	1	pm	1800	0	0	0	0	1	0	0	0
March	5	Pearson	3	am	630	2	0	0	0	0	0	0	0
March	5	Pearson	5	am	700	5	0	0	1	2	1	2	0
March	5	Pearson	2	am	730	1	0	9	1	0	0	0	0
March	5	Pearson	1	am	800	0	0	0	0	0	0	0	0

Appendix A

BIRD ABUNDANCE DATA-LAKES PEARSON AND GR

Data is number of birds observed and counted in a particular site within the time frame.

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
March	1	Pearson	4	am	630	0	0	0	0	0	0	0	0
March	1	Pearson	2	am	700	2	0	46	0	0	0	0	0
March	1	Pearson	1	am	730	0	0	0	0	0	0	0	0
March	1	Pearson	3	am	800	0	0	6	0	0	0	0	0
March	1	Pearson	5	am	830	0	0	20	0	0	0	0	0
March	2	Pearson	2	pm	1630	0	0	0	0	2	0	0	0
March	2	Pearson	3	pm	1700	0	0	0	0	0	0	0	0
March	2	Pearson	4	pm	1700	0	0	33	0	0	0	0	0
March	2	Pearson	1	pm	1800	0	0	60	0	0	0	0	0
March	2	Pearson	5	pm	1830	2	0	4	0	3	0	0	0
March	3	Pearson	2	am	630	4	0	6	0	0	0	0	0
March	3	Pearson	3	am	700	0	0	3	0	3	0	0	0
March	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
March	3	Pearson	5	am	800	0	0	0	0	2	0	0	0
March	3	Pearson	1	am	830	4	0	70	0	0	0	0	0
March	4	Pearson	3	pm	1630	0	0	11	0	0	0	0	0
March	4	Pearson	2	pm	1700	13	0	0	0	0	0	0	0
March	4	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
March	4	Pearson	5	pm	1750	2	0	0	0	0	0	0	0
March	4	Pearson	1	pm	1800	9	0	0	0	0	1	0	0
March	5	Pearson	3	am	630	0	0	1	0	0	0	0	0
March	5	Pearson	5	am	700	2	0	1	0	0	0	0	0
March	5	Pearson	2	am	730	0	2	0	0	0	0	0	0
March	5	Pearson	1	am	800	0	0	2	0	0	0	0	0

Appendix A

BIRD ABUNDANCE DATA-LAKES PEARSON AND GR

Data is number of birds observed and counted in a particular site within the time frame.

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
March	1	Pearson	4	am	630	0	0	0	0	0	0	0	0
March	1	Pearson	2	am	700	0	0	0	0	0	0	0	0
March	1	Pearson	1	am	730	0	0	0	0	0	0	0	0
March	1	Pearson	3	am	800	0	0	0	0	0	0	0	0
March	1	Pearson	5	am	830	0	0	0	0	0	0	0	0
March	2	Pearson	2	pm	1630	0	0	0	0	0	0	0	0
March	2	Pearson	3	pm	1700	0	0	0	0	0	0	0	0
March	2	Pearson	4	pm	1700	0	0	0	0	0	0	0	0
March	2	Pearson	1	pm	1800	0	0	0	0	0	0	0	0
March	2	Pearson	5	pm	1830	0	0	0	0	0	0	0	0
March	3	Pearson	2	am	630	0	0	0	0	0	0	0	0
March	3	Pearson	3	am	700	0	0	0	0	0	0	0	0
March	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
March	3	Pearson	5	am	800	0	0	0	0	0	0	0	0
March	3	Pearson	1	am	830	0	0	0	0	0	0	0	0
March	4	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
March	4	Pearson	2	pm	1700	0	0	0	0	0	0	0	0
March	4	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
March	4	Pearson	5	pm	1750	0	0	0	0	0	0	0	0
March	4	Pearson	1	pm	1800	0	0	0	0	0	0	0	0
March	5	Pearson	3	am	630	0	0	0	0	0	0	0	0
March	5	Pearson	5	am	700	0	0	0	0	0	0	0	0
March	5	Pearson	2	am	730	0	0	0	0	0	0	0	0
March	5	Pearson	1	am	800	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
March	5	Pearson	4	am	830	0	0	17	0	0	46	0	0
March	6	Pearson	1	pm	1630	0	1	0	0	0	0	2	0
March	6	Pearson	5	pm	1700	7	0	3	2	0	0	2	0
March	6	Pearson	4	pm	1730	3	0	0	0	0	0	0	0
March	6	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
March	6	Pearson	2	pm	1830	0	0	0	0	0	0	0	0
March	1	Grasmere	2	pm	1630	0	0	0	0	38	12	44	0
March	1	Grasmere	1	pm	1700	2	0	0	0	6	0	3	0
March	1	Grasmere	4	pm	1730	0	0	0	0	0	0	0	0
March	1	Grasmere	3	pm	1800	2	0	0	0	22	0	5	0
March	1	Grasmere	5	pm	1830	0	0	0	0	2	0	19	2
March	2	Grasmere	1	am	630	0	0	0	0	12	339	7	0
March	2	Grasmere	5	am	700	0	0	0	0	4	0	1	0
March	2	Grasmere	4	am	730	0	0	1	0	1	0	0	0
March	2	Grasmere	2	am	800	0	0	0	0	23	28	12	2
March	2	Grasmere	3	am	830	0	0	0	0	38	0	33	0
March	3	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
March	3	Grasmere	3	pm	1700	0	0	0	0	26	0	0	0
March	3	Grasmere	5	pm	1730	0	0	0	0	6	0	10	0
March	3	Grasmere	2	pm	1800	2	0	0	0	15	0	12	4
March	3	Grasmere	1	pm	1830	2	0	0	0	11	0	0	0
March	4	Grasmere	5	am	630	0	0	0	0	5	0	0	0
March	4	Grasmere	1	am	700	1	3	0	0	25	122	0	1
March	4	Grasmere	3	am	730	2	0	0	0	218	0	6	3
March	4	Grasmere	4	am	800	1	0	0	0	2	0	0	2
March	4	Grasmere	2	am	830	0	0	0	0	25	2	22	0
March	5	Grasmere	5	pm	1630	0	0	0	0	5	0	11	0
March	5	Grasmere	2	pm	1700	0	0	0	0	20	337		4
March	5	Grasmere	3	pm	1730	0	0	0	0	3	280	9	0
March	5	Grasmere	1	pm	1800	1	0	0	0	47	0	20	4

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
March	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
March	6	Pearson	1	pm	1630	2	0	0	0	3	0	0	0
March	6	Pearson	5	pm	1700	3	0	37	0	0	0	0	0
March	6	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
March	6	Pearson	3	pm	1800	0	0	15	0	0	0	0	0
March	6	Pearson	2	pm	1830	6	0	2	0	0	0	0	0
March	1	Grasmere	2	pm	1630	9	0	0	0	0	0	0	0
March	1	Grasmere	1	pm	1700	0	0	0	0	0	0	0	0
March	1	Grasmere	4	pm	1730	0	0	0	0	0	0	0	0
March	1	Grasmere	3	pm	1800	0	0	0	0	0	0	0	0
March	1	Grasmere	5	pm	1830	3	0	26	0	0	0	0	0
March	2	Grasmere	1	am	630	6	0	0	0	0	0	0	0
March	2	Grasmere	5	am	700	0	0	3	0	0	0	0	0
March	2	Grasmere	4	am	730	0	0	0	0	0	0	0	0
March	2	Grasmere	2	am	800	4	0	0	0	0	0	0	0
March	2	Grasmere	3	am	830	0	0	3	0	0	0	0	0
March	3	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
March	3	Grasmere	3	pm	1700	0	0	1	0	0	0	0	0
March	3	Grasmere	5	pm	1730	3	0	16	0	0	0	0	0
March	3	Grasmere	2	pm	1800	6	0	0	0	0	0	0	0
March	3	Grasmere	1	pm	1830	0	0	0	0	0	0	0	0
March	4	Grasmere	5	am	630	4	0	18	0	0	0	0	0
March	4	Grasmere	1	am	700	5	0	0	0	0	0	0	0
March	4	Grasmere	3	am	730	0	0	18	3	0	0	0	0
March	4	Grasmere	4	am	800	3	0	1	0	0	0	0	0
March	4	Grasmere	2	am	830	0	0	0	0	0	0	0	0
March	5	Grasmere	5	pm	1630	1	0	8	0	0	0	0	0
March	5	Grasmere	2	pm	1700	2	0	0	0	0	0	0	0
March	5	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
March	5	Grasmere	1	pm	1800	11	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
March	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
March	6	Pearson	1	pm	1630	0	0	0	0	0	0	0	0
March	6	Pearson	5	pm	1700	0	0	0	0	0	0	0	0
March	6	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
March	6	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
March	6	Pearson	2	pm	1830	0	0	0	0	0	0	0	0
March	1	Grasmere	2	pm	1630	0	0	0	0	0	0	0	0
March	1	Grasmere	1	pm	1700	0	0	0	0	0	0	0	0
March	1	Grasmere	4	pm	1730	0	0	0	0	0	0	0	0
March	1	Grasmere	3	pm	1800	0	0	0	0	0	0	0	0
March	1	Grasmere	5	pm	1830	0	0	0	0	0	0	0	0
March	2	Grasmere	1	am	630	0	0	0	0	0	0	0	0
March	2	Grasmere	5	am	700	0	0	0	0	0	0	0	0
March	2	Grasmere	4	am	730	0	0	0	0	0	0	0	0
March	2	Grasmere	2	am	800	0	0	0	0	0	0	0	0
March	2	Grasmere	3	am	830	0	0	0	0	0	0	0	0
March	3	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
March	3	Grasmere	3	pm	1700	0	0	0	0	0	0	0	0
March	3	Grasmere	5	pm	1730	0	0	0	0	0	0	0	0
March	3	Grasmere	2	pm	1800	0	0	0	0	0	0	0	0
March	3	Grasmere	1	pm	1830	0	0	0	0	0	0	0	0
March	4	Grasmere	5	am	630	0	0	0	0	0	0	0	0
March	4	Grasmere	1	am	700	0	0	0	0	0	0	0	0
March	4	Grasmere	3	am	730	0	0	0	0	0	0	0	0
March	4	Grasmere	4	am	800	0	0	0	0	0	0	0	0
March	4	Grasmere	2	am	830	0	0	0	0	0	0	0	0
March	5	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
March	5	Grasmere	2	pm	1700	0	0	0	0	0	0	0	0
March	5	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
March	5	Grasmere	1	pm	1800	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
March	5	Grasmere	4	pm	1830	0	0	0	0	1	0	0	0
April	1	Pearson	4	pm	1600	1	0	0	0	0	0	0	0
April	1	Pearson	1	pm	1630	0	0	0	0	0	0	8	2
April	1	Pearson	2	pm	1700	1	0	0	0	0	0	0	0
April	1	Pearson	5	pm	1730	4	0	0	0	0		0	0
April	1	Pearson	3	pm	1800	1	0	0	0	0	0	0	0
April	2	Pearson	3	am	700	3	0	0	0	0	0	0	0
April	2	Pearson	5	am	730	4	0	0	0	0	0	2	0
April	2	Pearson	2	am	800	3	0	6	1	0	0	0	1
April	2	Pearson	1	am	830	0	0	0	0	0	24	10	0
April	2	Pearson	4	am	900	0	0	0	0	0	0	0	0
April	3	Pearson	5	pm	1600	8	0	0	1	0	44	2	0
April	3	Pearson	3	pm	1630	3	0	0	0	0	0	0	0
April	3	Pearson	1	pm	1700	0	0	0	0	0	0	10	0
April	3	Pearson	2	pm	1730	2	0	0	0	0	0	0	0
April	3	Pearson	4	pm	1800	2	0	0	0	0	0	0	0
April	1	Grasmere	3	am	700	0	0	0	0	7	27	0	0
April	1	Grasmere	2	am	730	0	0	0	0	27	130	3	0
April	1	Grasmere	5	am	800	0	0	0	0	9	0	0	0
April	1	Grasmere	1	am	830	1	0	1	0	12	228	0	1
April	1	Grasmere	4	am	900	0	0	0	0	2	26	0	0
April	2	Grasmere	1	pm	1600	2	0	0	0	5	11	0	0
April	2	Grasmere	4	pm	1630	0	1	0	0	2	0	4	0
April	2	Grasmere	2	pm	1700	0	0	0	0	60	14	3	0
April	2	Grasmere	3	pm	1730	0	0	0	0	28	3	1	0
April	2	Grasmere	5	pm	1800	0	0	0	0	0	0	0	0
April	3	Grasmere	2	am	700	0	0	0	0	26	53	4	0
April	3	Grasmere	4	am	730	0	0	0	0	5	0	12	0
April	3	Grasmere	1	am	800	1	0	0	0	12	12	0	1
April	3	Grasmere	3	am	830	0	0	1	0	30	20	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
March	5	Grasmere	4	pm	1830	0	0	18	0	0	0	0	0
April	1	Pearson	4	pm	1600	0	0	0	0	0	0	0	0
April	1	Pearson	1	pm	1630	0	21	0	0	2	0	0	0
April	1	Pearson	2	pm	1700	0	0	0	0	0	0	0	0
April	1	Pearson	5	pm	1730	0	0	1	0	4	0	0	0
April	1	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
April	2	Pearson	3	am	700	0	0	30	0	0	0	0	0
April	2	Pearson	5	am	730	0	0	0	0	0	0	0	0
April	2	Pearson	2	am	800	1	0	0	0	0	0	0	0
April	2	Pearson	1	am	830	0	10	18	0	0	0	0	0
April	2	Pearson	4	am	900	0	0	0	0	0	0	0	0
April	3	Pearson	5	pm	1600	0	0	1	0	0	0	0	0
April	3	Pearson	3	pm	1630	0	0	42	0	0	0	0	0
April	3	Pearson	1	pm	1700	8	0	0	0	0	0	0	0
April	3	Pearson	2	pm	1730	0	0	0	0	0	0	0	0
April	3	Pearson	4	pm	1800	0	0	0	0	0	0	0	0
April	1	Grasmere	3	am	700	0	5	23	0	0	2	0	0
April	1	Grasmere	2	am	730	0	0	14	0	0	0	0	0
April	1	Grasmere	5	am	800	0	0	0	0	0	0	0	0
April	1	Grasmere	1	am	830	2	0	0	0	0	0	0	0
April	1	Grasmere	4	am	900	0	0	6	0	0	0	0	0
April	2	Grasmere	1	pm	1600	0	0	0	0	0	0	0	0
April	2	Grasmere	4	pm	1630	4	0	11	0	0	0	0	0
April	2	Grasmere	2	pm	1700	4	0	42	0	0	0	0	0
April	2	Grasmere	3	pm	1730	8	0	14	0	0	0	0	0
April	2	Grasmere	5	pm	1800	0	0	0	0	0	0	0	0
April	3	Grasmere	2	am	700	2	0	0	0	0	0	0	0
April	3	Grasmere	4	am	730	0	0	7	0	0	0	0	0
April	3	Grasmere	1	am	800	1	0	0	0	0	0	0	0
April	3	Grasmere	3	am	830	8	0	49	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
March	5	Grasmere	4	pm	1830	0	0	0	0	0	0	0	0
April	1	Pearson	4	pm	1600	0	0	0	0	0	0	0	0
April	1	Pearson	1	pm	1630	0	0	0	0	0	0	0	0
April	1	Pearson	2	pm	1700	0	0	0	0	0	0	0	0
April	1	Pearson	5	pm	1730	0	0	0	0	0	0	0	0
April	1	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
April	2	Pearson	3	am	700	0	0	0	0	0	0	0	0
April	2	Pearson	5	am	730	0	0	0	0	0	0	0	0
April	2	Pearson	2	am	800	0	0	0	0	0	0	0	0
April	2	Pearson	1	am	830	0	0	0	0	0	0	0	0
April	2	Pearson	4	am	900	0	0	0	0	0	0	0	0
April	3	Pearson	5	pm	1600	0	0	0	0	0	0	0	0
April	3	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
April	3	Pearson	1	pm	1700	0	0	0	0	0	0	0	0
April	3	Pearson	2	pm	1730	0	0	0	0	0	0	0	0
April	3	Pearson	4	pm	1800	0	0	0	0	0	0	0	0
April	1	Grasmere	3	am	700	0	0	0	0	0	0	0	0
April	1	Grasmere	2	am	730	0	0	0	0	0	0	0	0
April	1	Grasmere	5	am	800	0	0	0	0	0	0	0	0
April	1	Grasmere	1	am	830	0	0	0	0	0	0	0	0
April	1	Grasmere	4	am	900	0	0	0	0	0	0	0	0
April	2	Grasmere	1	pm	1600	0	0	0	0	0	0	0	0
April	2	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
April	2	Grasmere	2	pm	1700	0	0	0	0	0	0	0	0
April	2	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
April	2	Grasmere	5	pm	1800	0	0	0	0	0	0	0	0
April	3	Grasmere	2	am	700	0	0	0	0	0	0	0	0
April	3	Grasmere	4	am	730	0	0	0	0	0	0	0	0
April	3	Grasmere	1	am	800	0	0	0	0	0	0	0	0
April	3	Grasmere	3	am	830	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
April	3	Grasmere	5	am	900	0	0	0	0	7	0	3	0
May	1	Pearson	4	pm	1530	2	1	0	0	0	0	0	0
May	1	Pearson	2	pm	1600	1	1	2	0	5	0	0	1
May	1	Pearson	3	pm	1630	1	2	3	0	0	0	0	0
May	1	Pearson	5	pm	1700	0	0	0	0	0	0	0	0
May	1	Pearson	1	pm	1730	0	0	0	0	0	0	17	0
May	2	Pearson	3	am	730	2	0	0	0	2	0	0	0
May	2	Pearson	1	am	800	0	0	0	0	1	7	14	0
May	2	Pearson	5	am	830	2	0	0	0	0	14	4	0
May	2	Pearson	4	am	900	0	0	0	0	0	0	0	0
May	2	Pearson	2	am	930	2	2	6	0	0	0	0	0
May	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
May	3	Pearson	5	am	800	4	2	2	0	7	0	4	0
May	3	Pearson	2	am	830	0	2	2	0	6	0	0	0
May	3	Pearson	3	am	900	0	1	7	0	0	0	0	0
May	3	Pearson	1	am	930	0	0	7	0	0	8	17	0
May	4	Pearson	1	pm	1530	0	0	0	0	2	0	19	0
May	4	Pearson	4	pm	1600	1	0	1	0	0	0	0	0
May	4	Pearson	3	pm	1630	2	2	0	0	0	0	0	0
May	4	Pearson	5	pm	1700	2	0	0	0	2	13	2	4
May	4	Pearson	2	pm	1730	1	0	0	0	0	0	0	0
May	5	Pearson	1	am	730	0	0	0	0	0	45	16	0
May	5	Pearson	3	am	800	2	4	7	0	0	0	0	0
May	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
May	5	Pearson	5	am	900	1	1	1	0	0	0	0	0
May	5	Pearson	2	am	930	0	2	0	0	2	0	0	0
May	6	Pearson	3	pm	1530	1	1	0	0	0	0	0	0
May	6	Pearson	5	pm	1600	2	0	0	0	4	0	4	0
May	6	Pearson	2	pm	1630	1	0	2	0	0	0	0	0
May	6	Pearson	1	pm	1700	0	0	0	0	0	0	15	3

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
April	3	Grasmere	5	am	900	0	0	0	0	0	0	0	0
May	1	Pearson	4	pm	1530	0	0	0	0	0	0	0	0
May	1	Pearson	2	pm	1600	0	16	57	0	0	0	0	0
May	1	Pearson	3	pm	1630	0	0	19	0	0	0	0	0
May	1	Pearson	5	pm	1700	0	0	0	0	2	2	0	0
May	1	Pearson	1	pm	1730	0	2	0	0	0	0	0	0
May	2	Pearson	3	am	730	0	0	1	0	0	0	0	0
May	2	Pearson	1	am	800	1	0	0	0	2	0	0	0
May	2	Pearson	5	am	830	38	0	13	0	12	0	0	0
May	2	Pearson	4	am	900	0	0	1	0	0	0	0	0
May	2	Pearson	2	am	930	0	0	51	0	0	0	0	0
May	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
May	3	Pearson	5	am	800	0	0	0	0	0	0	0	0
May	3	Pearson	2	am	830	0	0	53	0	0	0	0	0
May	3	Pearson	3	am	900	2	0	2	0	0	0	0	0
May	3	Pearson	1	am	930	0	0	0	0	2	0	0	0
May	4	Pearson	1	pm	1530	0	0	0	0	0	0	0	0
May	4	Pearson	4	pm	1600	9	0	4	0	0	0	0	0
May	4	Pearson	3	pm	1630	0	0	55	0	0	0	0	0
May	4	Pearson	5	pm	1700	40	0	7	0	0	0	0	0
May	4	Pearson	2	pm	1730	2	0	2	0	0	0	0	0
May	5	Pearson	1	am	730	0	0	0	0	0	0	0	0
May	5	Pearson	3	am	800	0	17	5	0	0	0	0	0
May	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
May	5	Pearson	5	am	900	30	0	7	0	0	0	0	0
May	5	Pearson	2	am	930	0	0	15	0	0	0	1	0
May	6	Pearson	3	pm	1530	0	0	14	0	0	0	0	0
May	6	Pearson	5	pm	1600	0	0	1	0	2	0	0	0
May	6	Pearson	2	pm	1630	0	0	38	0	0	0	0	0
May	6	Pearson	1	pm	1700	7	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
April	3	Grasmere	5	am	900	0	0	0	0	0	0	0	0
May	1	Pearson	4	pm	1530	0	0	0	0	0	0	0	0
May	1	Pearson	2	pm	1600	0	0	0	0	0	0	0	0
May	1	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
May	1	Pearson	5	pm	1700	0	0	0	0	0	0	0	0
May	1	Pearson	1	pm	1730	0	0	0	0	0	0	0	0
May	2	Pearson	3	am	730	0	0	0	0	0	0	0	0
May	2	Pearson	1	am	800	0	0	0	0	0	0	0	0
May	2	Pearson	5	am	830	0	0	0	0	0	0	0	0
May	2	Pearson	4	am	900	0	0	0	0	0	0	0	0
May	2	Pearson	2	am	930	0	0	0	2	0	0	0	0
May	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
May	3	Pearson	5	am	800	0	0	0	0	0	0	0	0
May	3	Pearson	2	am	830	0	0	0	0	0	0	0	0
May	3	Pearson	3	am	900	0	0	0	0	0	0	0	0
May	3	Pearson	1	am	930	0	0	0	0	0	0	0	0
May	4	Pearson	1	pm	1530	0	0	0	0	0	0	0	0
May	4	Pearson	4	pm	1600	0	0	0	0	0	0	0	0
May	4	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
May	4	Pearson	5	pm	1700	0	0	0	0	2	0	0	0
May	4	Pearson	2	pm	1730	0	0	0	0	0	0	0	0
May	5	Pearson	1	am	730	0	0	0	0	0	0	0	0
May	5	Pearson	3	am	800	0	0	0	0	0	0	0	0
May	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
May	5	Pearson	5	am	900	0	0	0	0	0	0	0	0
May	5	Pearson	2	am	930	0	0	0	0	0	0	0	0
May	6	Pearson	3	pm	1530	0	0	0	0	0	0	0	0
May	6	Pearson	5	pm	1600	0	0	0	0	0	0	0	0
May	6	Pearson	2	pm	1630	0	0	0	0	0	0	0	0
May	6	Pearson	1	pm	1700	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
May	6	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
May	1	Grasmere	1	am	730	0	0	0	0	2	0	0	0
May	1	Grasmere	4	am	800	0	0	0	0	3	5	3	0
May	1	Grasmere	3	am	830	0	0	0	0	50	4	0	0
May	1	Grasmere	5	am	900	0	0	0	0	2	0	0	0
May	1	Grasmere	2	am	930	0	1	0	0	10	0	0	3
May	2	Grasmere	3	pm	1540	0	0	0	0	44	357	2	0
May	2	Grasmere	2	pm	1600	0	0	0	0	13	184	0	0
May	2	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
May	2	Grasmere	4	pm	1700	0	1	0	0	0	0	1	0
May	2	Grasmere	1	pm	1730	1	0	0	0	2	137	0	0
May	3	Grasmere	1	pm	1530	1	0	1	0	8	299	0	0
May	3	Grasmere	2	pm	1600	1	0	0	0	15	52	0	0
May	3	Grasmere	4	pm	1630	0	0	0	0	0	4	0	0
May	3	Grasmere	5	pm	1700	0	0	0	0	0	0	0	0
May	3	Grasmere	3	pm	1730	0	0	0	0	49	388	2	0
May	4	Grasmere	2	am	730	0	0	0	0	32	169	0	0
May	4	Grasmere	3	am	800	0	0	0	0	31	108	0	0
May	4	Grasmere	1	am	830	0	0	0	0	2	9	0	2
May	4	Grasmere	4	am	900	0	0	0	0	8	1	0	0
May	4	Grasmere	5	am	930	0	0	0	0	0	0	0	0
May	5	Grasmere	2	pm	1530	1	0	0	0	27	126	0	0
May	5	Grasmere	5	pm	1600	0	0	0	0	0	0	0	0
May	5	Grasmere	1	pm	1630	1	0	0	0	2	52	0	0
May	5	Grasmere	3	pm	1700	0	0	0	0	52	149	0	0
May	5	Grasmere	4	pm	1730	0	0	0	0	1	0	0	0
May	6	Grasmere	5	am	740	2	0	0	0	0	0	0	0
May	6	Grasmere	4	am	800	0	0	0	0	6	55	0	0
May	6	Grasmere	1	am	830	2	0	1	0	4	0	0	1
May	6	Grasmere	2	am	900	0	0	0	0	35	355	10	2

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
May	6	Pearson	4	pm	1730	0	0	4	0	0	0	0	0
May	1	Grasmere	1	am	730	0	0	12	0	0	0	0	0
May	1	Grasmere	4	am	800	0	8	127	0	0	0	0	0
May	1	Grasmere	3	am	830	0	18	46	0	0	0	0	0
May	1	Grasmere	5	am	900	0	0	8	0	0	0	0	0
May	1	Grasmere	2	am	930	2	0	1	0	0	0	0	0
May	2	Grasmere	3	pm	1540	1	0	0	0	0	0	0	0
May	2	Grasmere	2	pm	1600	0	0	52	0	0	0	0	0
May	2	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
May	2	Grasmere	4	pm	1700	10	0	0	0	0	0	0	0
May	2	Grasmere	1	pm	1730	0	0	44	0	0	0	0	0
May	3	Grasmere	1	pm	1530	0	0	10	0	0	0	0	0
May	3	Grasmere	2	pm	1600	0	0	0	0	0	0	0	0
May	3	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
May	3	Grasmere	5	pm	1700	0	0	4	0	0	0	0	0
May	3	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
May	4	Grasmere	2	am	730	0	0	16	0	0	0	0	0
May	4	Grasmere	3	am	800	0	0	8	0	0	0	0	0
May	4	Grasmere	1	am	830	2	0	43	0	0	0	0	0
May	4	Grasmere	4	am	900	0	0	94	0	0	0	0	0
May	4	Grasmere	5	am	930	0	0	0	0	0	0	0	0
May	5	Grasmere	2	pm	1530	1	0	9	0	0	0	0	0
May	5	Grasmere	5	pm	1600	0	0	7	0	0	0	0	0
May	5	Grasmere	1	pm	1630	0	0	0	0	0	0	0	0
May	5	Grasmere	3	pm	1700	3	0	121	0	0	0	0	0
May	5	Grasmere	4	pm	1730	1	0	43	0	0	0	0	0
May	6	Grasmere	5	am	740	0	0	0	0	0	0	0	0
May	6	Grasmere	4	am	800	0	10	100	0	0	0	0	0
May	6	Grasmere	1	am	830	7	0	0	0	0	0	0	0
May	6	Grasmere	2	am	900	8	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
May	6	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
May	1	Grasmere	1	am	730	0	0	0	0	0	0	0	0
May	1	Grasmere	4	am	800	0	0	0	0	0	0	0	0
May	1	Grasmere	3	am	830	0	0	0	0	0	0	0	0
May	1	Grasmere	5	am	900	0	0	0	0	0	0	0	0
May	1	Grasmere	2	am	930	0	0	0	0	0	0	0	0
May	2	Grasmere	3	pm	1540	0	0	0	0	0	0	0	0
May	2	Grasmere	2	pm	1600	0	0	0	0	0	0	0	0
May	2	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
May	2	Grasmere	4	pm	1700	0	0	0	0	0	0	0	0
May	2	Grasmere	1	pm	1730	0	0	0	0	0	0	0	0
May	3	Grasmere	1	pm	1530	0	0	0	0	0	0	0	0
May	3	Grasmere	2	pm	1600	0	0	0	0	0	0	0	0
May	3	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
May	3	Grasmere	5	pm	1700	0	0	0	0	0	0	0	0
May	3	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
May	4	Grasmere	2	am	730	0	0	0	0	0	0	0	0
May	4	Grasmere	3	am	800	0	0	0	0	0	0	0	0
May	4	Grasmere	1	am	830	0	0	0	0	0	0	0	0
May	4	Grasmere	4	am	900	0	0	0	0	0	0	0	0
May	4	Grasmere	5	am	930	0	0	0	0	0	0	0	0
May	5	Grasmere	2	pm	1530	0	0	0	0	0	0	0	0
May	5	Grasmere	5	pm	1600	0	0	0	0	0	0	0	0
May	5	Grasmere	1	pm	1630	0	0	0	0	0	0	0	0
May	5	Grasmere	3	pm	1700	0	0	0	0	0	0	0	0
May	5	Grasmere	4	pm	1730	0	0	0	0	0	0	0	0
May	6	Grasmere	5	am	740	0	0	0	0	0	0	0	0
May	6	Grasmere	4	am	800	0	0	0	0	0	0	0	0
May	6	Grasmere	1	am	830	0	0	0	0	0	0	0	0
May	6	Grasmere	2	am	900	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
May	6	Grasmere	3	am	930	0	0	0	0	46	560	2	0
June	1	Pearson	4	pm	1500	0	0	0	0	0	0	0	0
June	1	Pearson	1	pm	1530	0	0	0	0	0	0	16	3
June	1	Pearson	2	pm	1600	1	2	2	0	0	0	0	0
June	1	Pearson	5	pm	1630	1	0	0	0	2	0	0	0
June	1	Pearson	3	pm	1700	0	0	3	0	0	0	0	0
June	2	Pearson	5	am	800	1	0	0	0	0	0	0	2
June	2	Pearson	1	am	830	0	0	0	0	3	0	12	0
June	2	Pearson	3	am	900	1	1	1	0	0	0	0	0
June	2	Pearson	2	am	930	0	0	0	0	3	0	4	0
June	2	Pearson	4	am	1000	0	0	0	0	0	0	0	0
June	3	Pearson	1	pm	1500	0	0	0	0	2	0	7	3
June	3	Pearson	4	pm	1530	0	0	0	0	0	0	2	2
June	3	Pearson	2	pm	1600	0	2	1	0	0	0	0	0
June	3	Pearson	3	pm	1630	0	2	1	0	0	0	0	0
June	3	Pearson	5	pm	1700	2	1	0	0	0	0	2	5
June	4	Pearson	2	am	800	0	0	1	0	0	0	0	0
June	4	Pearson	1	am	830	0	1	0	0	2	0	19	0
June	4	Pearson	5	am	900	0	2	0	0	0	0	2	1
June	4	Pearson	4	am	930	0	0	0	0	0	0	0	0
June	4	Pearson	3	am	1000	0	0	0	0	0	0	0	0
June	5	Pearson	4	pm	1500	0	0	0	0	0	0	0	0
June	5	Pearson	1	pm	1530	0	0	0	0	2	0	5	5
June	5	Pearson	3	pm	1600	2	0	3	0	0	0	0	0
June	5	Pearson	2	pm	1630	0	0	3	0	0	0	0	0
June	5	Pearson	5	pm	1700	2	0	0	0	0	8	0	2
June	6	Pearson	5	am	800	1	0	0	0	0	6	2	0
June	6	Pearson	2	am	830	0	0	3	0	0	0	0	0
June	6	Pearson	4	am	900	0	0	1	0	0	0	0	0
June	6	Pearson	3	am	930	1	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
May	6	Grasmere	3	am	930	9	0	0	0	0	0	0	0
June	1	Pearson	4	pm	1500	0	0	0	0	0	0	0	0
June	1	Pearson	1	pm	1530	0	34	0	0	0	0	0	0
June	1	Pearson	2	pm	1600	0	0	0	0	0	0	0	0
June	1	Pearson	5	pm	1630	0	2	0	0	0	0	0	0
June	1	Pearson	3	pm	1700	0	0	38	0	0	0	0	0
June	2	Pearson	5	am	800	0	0	1	0	0	0	1	0
June	2	Pearson	1	am	830	0	0	0	0	0	0	0	0
June	2	Pearson	3	am	900	0	0	18	0	0	0	0	0
June	2	Pearson	2	am	930	0	0	30	0	0	0	0	0
June	2	Pearson	4	am	1000	0	0	0	0	0	0	0	0
June	3	Pearson	1	pm	1500	6	0	0	0	0	0	1	0
June	3	Pearson	4	pm	1530	0	0	0	0	0	0	0	0
June	3	Pearson	2	pm	1600	0	0	33	0	0	0	0	0
June	3	Pearson	3	pm	1630	0	0	10	0	0	0	0	0
June	3	Pearson	5	pm	1700	6	0	2	0	0	0	0	0
June	4	Pearson	2	am	800	0	0	28	0	0	0	0	0
June	4	Pearson	1	am	830	15	0	0	0	2	0	1	0
June	4	Pearson	5	am	900	41	0	0	0	0	0	0	0
June	4	Pearson	4	am	930	0	0	0	0	0	0	0	0
June	4	Pearson	3	am	1000	0	0	11	0	0	0	0	0
June	5	Pearson	4	pm	1500	0	0	0	0	0	0	0	0
June	5	Pearson	1	pm	1530	29	0	0	0	0	0	1	0
June	5	Pearson	3	pm	1600	21	0	15	0	0	0	0	0
June	5	Pearson	2	pm	1630	0	0	20	0	0	0	0	0
June	5	Pearson	5	pm	1700	30	0	9	0	0	0	0	0
June	6	Pearson	5	am	800	0	4	0	0	5	0	0	0
June	6	Pearson	2	am	830	0	0	42	0	0	0	0	0
June	6	Pearson	4	am	900	0	0	0	0	0	0	0	0
June	6	Pearson	3	am	930	0	0	1	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
May	6	Grasmere	3	am	930	0	0	0	0	0	0	0	0
June	1	Pearson	4	pm	1500	0	0	0	0	0	0	0	0
June	1	Pearson	1	pm	1530	0	0	0	0	0	0	0	0
June	1	Pearson	2	pm	1600	0	0	0	0	0	0	0	0
June	1	Pearson	5	pm	1630	0	1	0	0	0	0	0	0
June	1	Pearson	3	pm	1700	0	0	0	0	0	0	0	0
June	2	Pearson	5	am	800	0	1	0	0	0	0	0	0
June	2	Pearson	1	am	830	0	0	0	0	0	0	0	0
June	2	Pearson	3	am	900	0	0	0	0	0	0	0	0
June	2	Pearson	2	am	930	0	0	0	0	0	0	0	0
June	2	Pearson	4	am	1000	0	0	0	0	0	0	0	0
June	3	Pearson	1	pm	1500	0	0	0	0	0	0	0	0
June	3	Pearson	4	pm	1530	0	0	0	0	0	0	0	0
June	3	Pearson	2	pm	1600	0	0	0	0	0	0	0	0
June	3	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
June	3	Pearson	5	pm	1700	0	0	0	0	0	0	0	0
June	4	Pearson	2	am	800	0	0	0	2	0	0	0	0
June	4	Pearson	1	am	830	0	0	0	0	0	0	0	0
June	4	Pearson	5	am	900	0	0	0	4	0	0	0	0
June	4	Pearson	4	am	930	0	0	0	0	0	0	0	0
June	4	Pearson	3	am	1000	0	0	0	0	0	0	0	0
June	5	Pearson	4	pm	1500	0	0	0	0	0	0	0	0
June	5	Pearson	1	pm	1530	0	0	0	0	0	0	0	0
June	5	Pearson	3	pm	1600	0	0	0	0	0	0	0	0
June	5	Pearson	2	pm	1630	0	0	0	0	0	0	0	0
June	5	Pearson	5	pm	1700	0	0	0	0	0	0	0	0
June	6	Pearson	5	am	800	0	0	0	0	0	0	0	0
June	6	Pearson	2	am	830	0	0	0	2	0	0	0	0
June	6	Pearson	4	am	900	0	0	0	0	0	0	0	0
June	6	Pearson	3	am	930	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
June	6	Pearson	1	am	1000	0	0	0	0	2	87	6	0
June	1	Grasmere	1	am	800	0	0	0	0	2	258	0	2
June	1	Grasmere	4	am	830	0	0	0	0	0	66	0	0
June	1	Grasmere	2	am	900	0	0	0	0	32	271	0	0
June	1	Grasmere	3	am	930	0	0	0	0	22	202	0	0
June	1	Grasmere	5	am	1000	0	3	0	0	0	0	0	0
June	2	Grasmere	3	pm	1500	0	0	0	0	39	63	1	0
June	2	Grasmere	4	pm	1530	0	0	0	0	1	0	0	0
June	2	Grasmere	1	pm	1600	0	0	0	0	9	556	0	0
June	2	Grasmere	2	pm	1630	0	0	0	0	23	54	0	2
June	2	Grasmere	5	pm	1700	0	0	0	0	3	0	0	0
June	3	Grasmere	2	am	800	1	0	0	0	26	160	0	2
June	3	Grasmere	4	am	830	0	0	0	0	4	47	0	0
June	3	Grasmere	1	am	900	1	0	1	0	16	255	0	2
June	3	Grasmere	3	am	930	1	0	0	0	44	116	0	7
June	3	Grasmere	5	am	1000	0	0	1	0	1	0	0	0
June	4	Grasmere	1	pm	1500	1	1	0	0	13	378	2	0
June	4	Grasmere	5	pm	1530	1	0	0	0	0	0	0	0
June	4	Grasmere	3	pm	1600	0	0	1	0	44	26	0	0
June	4	Grasmere	4	pm	1630	0	1	0	0	2	2	0	0
June	4	Grasmere	2	pm	1700	0	0	0	0	35	288	0	4
June	5	Grasmere	2	am	800	0	0	0	0	18	115	0	0
June	5	Grasmere	4	am	830	0	1	0	0	26	76	0	0
June	5	Grasmere	1	am	900	2	0	0	0	7	190	0	0
June	5	Grasmere	3	am	930	0	0	0	0	32	228	0	0
June	5	Grasmere	5	am	1000	0	0	0	0	0	0	0	0
June	6	Grasmere	5	pm	1500	0	0	0	0	8	0	0	0
June	6	Grasmere	2	pm	1530	0	0	0	0	23	67	0	1
June	6	Grasmere	4	pm	1600	0	0	0	0	37	72	0	0
June	6	Grasmere	3	pm	1630	0	0	0	0	25	383	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
June	6	Pearson	1	am	1000	13	0	0	0	2	0	1	0
June	1	Grasmere	1	am	800	0	0	69	0	0	0	0	0
June	1	Grasmere	4	am	830	0	0	117	0	0	0	0	0
June	1	Grasmere	2	am	900	0	0	0	0	0	0	0	0
June	1	Grasmere	3	am	930	0	0	15	0	0	0	0	0
June	1	Grasmere	5	am	1000	0	0	0	0	0	0	0	0
June	2	Grasmere	3	pm	1500	0	9	0	0	0	0	0	0
June	2	Grasmere	4	pm	1530	2	0	0	0	0	0	0	0
June	2	Grasmere	1	pm	1600	0	0	0	0	0	0	0	0
June	2	Grasmere	2	pm	1630	0	0	0	0	0	0	0	0
June	2	Grasmere	5	pm	1700	0	0	3	0	0	0	0	0
June	3	Grasmere	2	am	800	0	0	23	0	0	0	0	0
June	3	Grasmere	4	am	830	0	0	93	0	0	0	0	0
June	3	Grasmere	1	am	900	3	0	1	0	0	0	0	0
June	3	Grasmere	3	am	930	0	0	21	0	0	0	0	0
June	3	Grasmere	5	am	1000	0	0	10	0	0	0	0	0
June	4	Grasmere	1	pm	1500	0	0	0	0	0	0	0	0
June	4	Grasmere	5	pm	1530	0	0	9	0	0	0	0	0
June	4	Grasmere	3	pm	1600	2	0	20	0	0	0	0	0
June	4	Grasmere	4	pm	1630	0	0	20	0	0	0	0	0
June	4	Grasmere	2	pm	1700	0	0	114	0	0	0	0	0
June	5	Grasmere	2	am	800	0	2	0	0	0	0	0	0
June	5	Grasmere	4	am	830	0	0	72	0	0	0	0	0
June	5	Grasmere	1	am	900	0	0	43	0	0	0	0	0
June	5	Grasmere	3	am	930	2	5	5	0	0	0	0	0
June	5	Grasmere	5	am	1000	0	0	0	0	0	0	0	0
June	6	Grasmere	5	pm	1500	0	2	30	0	0	0	0	0
June	6	Grasmere	2	pm	1530	2	1	0	0	0	0	0	0
June	6	Grasmere	4	pm	1600	0	0	121	0	0	0	0	0
June	6	Grasmere	3	pm	1630	0	0	14	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtem	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
June	6	Pearson	1	am	1000	0	0	0	0	0	0	0	0
June	1	Grasmere	1	am	800	0	0	0	0	0	0	0	0
June	1	Grasmere	4	am	830	0	0	0	0	0	0	0	0
June	1	Grasmere	2	am	900	0	0	0	0	0	0	0	0
June	1	Grasmere	3	am	930	0	0	0	0	0	0	0	0
June	1	Grasmere	5	am	1000	0	0	0	0	0	0	0	0
June	2	Grasmere	3	pm	1500	0	0	0	0	0	0	0	0
June	2	Grasmere	4	pm	1530	0	0	0	0	0	0	0	0
June	2	Grasmere	1	pm	1600	0	0	0	0	0	0	0	0
June	2	Grasmere	2	pm	1630	0	0	0	0	0	0	0	0
June	2	Grasmere	5	pm	1700	0	0	0	0	0	0	0	0
June	3	Grasmere	2	am	800	0	0	0	0	0	0	0	0
June	3	Grasmere	4	am	830	0	0	0	0	0	0	0	0
June	3	Grasmere	1	am	900	0	0	0	0	0	0	0	0
June	3	Grasmere	3	am	930	0	0	0	0	0	0	0	0
June	3	Grasmere	5	am	1000	0	0	0	0	0	0	0	0
June	4	Grasmere	1	pm	1500	0	0	0	0	0	0	0	0
June	4	Grasmere	5	pm	1530	0	0	0	0	0	0	0	0
June	4	Grasmere	3	pm	1600	0	0	0	0	0	0	0	0
June	4	Grasmere	4	pm	1630	0	0	0	0	0	0	0	0
June	4	Grasmere	2	pm	1700	0	0	0	0	0	0	0	0
June	5	Grasmere	2	am	800	0	0	0	0	0	0	0	0
June	5	Grasmere	4	am	830	0	0	0	0	0	0	0	0
June	5	Grasmere	1	am	900	0	0	0	0	0	0	0	0
June	5	Grasmere	3	am	930	0	0	0	0	0	0	0	0
June	5	Grasmere	5	am	1000	0	0	0	0	0	0	0	0
June	6	Grasmere	5	pm	1500	0	0	0	0	0	0	0	0
June	6	Grasmere	2	pm	1530	0	0	0	0	0	0	0	0
June	6	Grasmere	4	pm	1600	0	0	0	0	0	0	0	0
June	6	Grasmere	3	pm	1630	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
June	6	Grasmere	1	pm	1700	2	0	0	0	4	82	0	2
August	1	Pearson	5	pm	1530	1	0	0	0	2	0	0	0
August	1	Pearson	1	pm	1600	0	0	0	0	0	0	0	0
August	1	Pearson	3	pm	1630	1	0	1	0	0	0	0	0
August	1	Pearson	4	pm	1700	1	0	0	0	0	0	0	0
August	1	Pearson	2	pm	1730	0	0	0	0	0	0	0	0
August	2	Pearson	3	pm	1530	4	0	1	0	0	0	0	0
August	2	Pearson	5	pm	1600	5	0	0	0	2	19	0	0
August	2	Pearson	4	pm	1630	2	0	0	0	0	0	0	0
August	2	Pearson	2	pm	1700	0	1	0	0	0	0	0	0
August	2	Pearson	1	pm	1730	0	0	0	0	0	0	4	3
August	3	Pearson	4	am	730	2	2	0	0	0	6	0	0
August	3	Pearson	5	am	800	1	0	0	0	0	22	0	0
August	3	Pearson	3	am	830	0	0	0	0	0	0	0	0
August	3	Pearson	1	am	900	0	0	0	0	0	0	0	0
August	3	Pearson	2	am	930	0	0	0	0	0	0	0	0
August	4	Pearson	2	pm	1530	1	0	0	0	0	0	0	0
August	4	Pearson	5	pm	1600	3	1	0	0	0	9	0	0
August	4	Pearson	1	pm	1630	0	1	0	0	1	0	2	0
August	4	Pearson	4	pm	1700	0	0	1	0	0	0	0	0
August	4	Pearson	3	pm	1730	2	0	2	0	0	0	0	0
August	5	Pearson	5	am	730	1	0	0	0	2	0	0	0
August	5	Pearson	3	am	800	2	0	0	0	0	0	0	0
August	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
August	5	Pearson	2	am	900	0	0	0	0	2	0	0	0
August	5	Pearson	1	am	930	0	0	0	0	0	0	0	0
August	6	Pearson	1	am	730	0	0	0	0	0	0	0	0
August	6	Pearson	4	am	800	1	0	0	0	0	0	0	0
August	6	Pearson	5	am	830	1	0	0	0	0	0	0	0
August	6	Pearson	3	am	900	1	0	3	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
June	6	Grasmere	1	pm	1700	0	0	2	0	0	0	0	0
August	1	Pearson	5	pm	1530	0	0	0	0	0	0	0	0
August	1	Pearson	1	pm	1600	0	0	0	0	0	0	0	0
August	1	Pearson	3	pm	1630	0	0	12	0	0	0	0	0
August	1	Pearson	4	pm	1700	0	0	0	0	0	0	0	0
August	1	Pearson	2	pm	1730	0	0	0	0	0	0	0	0
August	2	Pearson	3	pm	1530	0	0	58	0	0	0	0	0
August	2	Pearson	5	pm	1600	2	0	1	0	0	0	0	0
August	2	Pearson	4	pm	1630	0	0	18	0	0	0	0	0
August	2	Pearson	2	pm	1700	0	0	0	0	0	0	0	0
August	2	Pearson	1	pm	1730	10	0	0	0	0	0	0	0
August	3	Pearson	4	am	730	0	0	12	0	0	0	0	0
August	3	Pearson	5	am	800	8	0	3	0	0	0	3	0
August	3	Pearson	3	am	830	0	0	0	0	0	0	0	0
August	3	Pearson	1	am	900	0	0	0	0	0	0	0	0
August	3	Pearson	2	am	930	0	0	0	0	0	0	0	0
August	4	Pearson	2	pm	1530	2	0	0	0	0	0	0	0
August	4	Pearson	5	pm	1600	0	0	0	0	0	0	10	0
August	4	Pearson	1	pm	1630	2	0		0	0	0	0	0
August	4	Pearson	4	pm	1700	2	0	0	0	0	0	1	0
August	4	Pearson	3	pm	1730	2	0	22	0	0	0	0	0
August	5	Pearson	5	am	730	0	0	1	0	0	0	1	0
August	5	Pearson	3	am	800	0	0	24	0	0	0	0	0
August	5	Pearson	4	am	830	0	0	2	0	0	0	0	0
August	5	Pearson	2	am	900	0	8	0	0	0	0	0	0
August	5	Pearson	1	am	930	0	0	0	0	0	0	0	0
August	6	Pearson	1	am	730	0	0	0	0	1	0	0	0
August	6	Pearson	4	am	800	0	0	1	0	0	0	1	0
August	6	Pearson	5	am	830	0	0	0	0	0	0	0	0
August	6	Pearson	3	am	900	19	0	45	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtem	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
June	6	Grasmere	1	pm	1700	0	0	0	0	0	0	0	0
August	1	Pearson	5	pm	1530	0	0	0	0	0	0	0	0
August	1	Pearson	1	pm	1600	0	0	0	0	0	0	0	0
August	1	Pearson	3	pm	1630	0	0	0	0	0	0	0	0
August	1	Pearson	4	pm	1700	0	0	0	0	0	0	0	0
August	1	Pearson	2	pm	1730	0	0	0	0	0	0	0	0
August	2	Pearson	3	pm	1530	0	0	0	0	0	0	0	0
August	2	Pearson	5	pm	1600	0	0	0	0	0	0	0	0
August	2	Pearson	4	pm	1630	0	0	0	0	0	0	0	0
August	2	Pearson	2	pm	1700	0	0	0	0	0	0	0	0
August	2	Pearson	1	pm	1730	0	0	0	0	0	0	0	0
August	3	Pearson	4	am	730	0	0	0	0	0	0	0	0
August	3	Pearson	5	am	800	0	0	0	0	0	0	0	0
August	3	Pearson	3	am	830	0	0	0	0	0	0	0	0
August	3	Pearson	1	am	900	1	0	0	0	0	0	0	0
August	3	Pearson	2	am	930	0	0	0	0	0	0	0	0
August	4	Pearson	2	pm	1530	0	0	0	0	0	0	0	0
August	4	Pearson	5	pm	1600	2	0	0	0	0	0	0	0
August	4	Pearson	1	pm	1630	0	0	0	0	0	0	0	0
August	4	Pearson	4	pm	1700	0	0	0	0	0	0	0	0
August	4	Pearson	3	pm	1730	0	0	0	0	0	0	0	0
August	5	Pearson	5	am	730	0	0	0	0	0	0	0	0
August	5	Pearson	3	am	800	0	0	0	0	0	0	0	0
August	5	Pearson	4	am	830	0	0	0	0	0	0	0	0
August	5	Pearson	2	am	900	0	0	0	0	0	0	0	0
August	5	Pearson	1	am	930	0	0	0	0	0	0	0	0
August	6	Pearson	1	am	730	0	0	0	0	0	0	0	0
August	6	Pearson	4	am	800	0	0	0	0	0	0	0	0
August	6	Pearson	5	am	830	0	0	0	0	0	0	0	0
August	6	Pearson	3	am	900	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
August	6	Pearson	2	am	930	0	0	0	0	0	0	0	0
August	1	Grasmere	5	am	730	0	0	0	0	3	0	0	0
August	1	Grasmere	4	am	800	0	0	0	0	4	8	0	0
August	1	Grasmere	3	am	830	0	1	0	0	5	0	0	2
August	1	Grasmere	2	am	900	0	0	0	0	5	1	0	0
August	1	Grasmere	1	am	930	0	0	0	0	0	0	0	0
August	2	Grasmere	1	am	730	0	0	0	0	2	4	0	0
August	2	Grasmere	3	am	800	0	0	0	0	7	0	2	1
August	2	Grasmere	5	am	830	0	0	0	0	5	0	0	0
August	2	Grasmere	4	am	900	0	0	0	0	4	0	0	0
August	2	Grasmere	2	am	930	0	0	0	0	4	1	0	0
August	3	Grasmere	2	pm	1530	0	0	0	0	5	74	0	0
August	3	Grasmere	5	pm	1600	0	0	0	0	0	0	0	0
August	3	Grasmere	1	pm	1630	0	0	0	0	2	300	0	0
August	3	Grasmere	4	pm	1700	0	0	0	0	0	2	0	0
August	3	Grasmere	3	pm	1730	0	0	0	0	5	8	4	2
August	4	Grasmere	4	am	730	0	0	0	0	0	0	0	0
August	4	Grasmere	2	am	800	0	0	0	0	7	54	0	0
August	4	Grasmere	5	am	830	0	0	0	0	2	0	0	0
August	4	Grasmere	1	am	900	0	0	0	0	2	0	0	0
August	4	Grasmere	3	am	930	0	0	1	0	6	0	0	0
August	5	Grasmere	3	pm	1530	1	0	0	0	11	0	2	2
August	5	Grasmere	1	pm	1600	0	1	0	0	2	7	0	0
August	5	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
August	5	Grasmere	4	pm	1700	0	0	0	0	2	137	0	0
August	5	Grasmere	2	pm	1730	0	0	0	0	9	5	0	0
August	6	Grasmere	2	pm	1530	0	0	0	0	2	0	0	0
August	6	Grasmere	5	pm	1600	0	0	0	0	3	0	0	0
August	6	Grasmere	1	pm	1630	0	0	0	0	1	0	0	0
August	6	Grasmere	4	pm	1700	0	0	0	0	3	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
August	6	Pearson	2	am	930	0	0	3	0	0	0	0	0
August	1	Grasmere	5	am	730	0	0	36	0	0	0	0	0
August	1	Grasmere	4	am	800	2	0	0	0	0	0	0	0
August	1	Grasmere	3	am	830	0	0	0	0	0	0	0	0
August	1	Grasmere	2	am	900	0	0	0	0	0	0	0	0
August	1	Grasmere	1	am	930	0	0	0	0	0	0	0	0
August	2	Grasmere	1	am	730	0	0	0	0	0	0	0	0
August	2	Grasmere	3	am	800	0	3	0	0	0	0	0	0
August	2	Grasmere	5	am	830	0	0	46	0	0	0	0	0
August	2	Grasmere	4	am	900	0	0	5	0	0	0	0	0
August	2	Grasmere	2	am	930	0	0	0	0	0	0	0	0
August	3	Grasmere	2	pm	1530	0	0	0	0	0	0	0	0
August	3	Grasmere	5	pm	1600	0	0	0	0	0	0	2	0
August	3	Grasmere	1	pm	1630	0	0	0	0	0	0	0	0
August	3	Grasmere	4	pm	1700	0	0	0	0	0	0	0	0
August	3	Grasmere	3	pm	1730	0	6	4	0	0	0	0	0
August	4	Grasmere	4	am	730	0	0	0	0	0	0	0	0
August	4	Grasmere	2	am	800	0	0	0	0	0	0	0	0
August	4	Grasmere	5	am	830	0	0	5	0	0	0	0	0
August	4	Grasmere	1	am	900	0	0	0	0	0	0	0	0
August	4	Grasmere	3	am	930	0	0	0	0	0	0	0	0
August	5	Grasmere	3	pm	1530	0	7	0	0	0	0	0	0
August	5	Grasmere	1	pm	1600	0	0	0	0	0	0	0	0
August	5	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
August	5	Grasmere	4	pm	1700	0	0	0	0	0	0	0	0
August	5	Grasmere	2	pm	1730	0	0	0	0	0	0	0	0
August	6	Grasmere	2	pm	1530	0	0	39	0	0	0	0	0
August	6	Grasmere	5	pm	1600	0	0	25	0	0	0	0	0
August	6	Grasmere	1	pm	1630	0	0	0	0	0	0	0	0
August	6	Grasmere	4	pm	1700	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
August	6	Pearson	2	am	930	0	0	0	0	0	0	0	0
August	1	Grasmere	5	am	730	0	0	0	0	0	0	0	0
August	1	Grasmere	4	am	800	0	0	0	0	0	0	0	0
August	1	Grasmere	3	am	830	0	0	0	0	0	0	0	0
August	1	Grasmere	2	am	900	0	0	0	0	0	0	0	0
August	1	Grasmere	1	am	930	0	0	0	0	0	0	0	0
August	2	Grasmere	1	am	730	0	0	0	0	0	0	0	0
August	2	Grasmere	3	am	800	0	0	0	0	0	0	0	0
August	2	Grasmere	5	am	830	0	0	0	0	0	0	0	0
August	2	Grasmere	4	am	900	0	0	0	0	0	0	0	0
August	2	Grasmere	2	am	930	0	0	0	0	0	0	0	0
August	3	Grasmere	2	pm	1530	0	0	0	0	0	0	0	0
August	3	Grasmere	5	pm	1600	0	0	0	0	0	0	0	0
August	3	Grasmere	1	pm	1630	0	0	0	0	0	0	0	0
August	3	Grasmere	4	pm	1700	0	1	0	0	0	0	0	0
August	3	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
August	4	Grasmere	4	am	730	0	0	0	0	0	0	0	0
August	4	Grasmere	2	am	800	0	0	0	0	0	0	0	0
August	4	Grasmere	5	am	830	0	0	0	0	0	0	0	0
August	4	Grasmere	1	am	900	0	0	0	0	0	0	0	0
August	4	Grasmere	3	am	930	0	0	0	0	0	0	0	0
August	5	Grasmere	3	pm	1530	0	0	0	0	0	0	0	0
August	5	Grasmere	1	pm	1600	0	0	0	0	0	0	0	0
August	5	Grasmere	5	pm	1630	0	0	0	0	0	0	0	0
August	5	Grasmere	4	pm	1700	0	0	0	0	0	0	0	0
August	5	Grasmere	2	pm	1730	0	0	0	0	0	0	0	0
August	6	Grasmere	2	pm	1530	0	0	0	0	0	0	0	0
August	6	Grasmere	5	pm	1600	0	0	0	0	0	0	0	0
August	6	Grasmere	1	pm	1630	0	0	0	0	0	0	0	0
August	6	Grasmere	4	pm	1700	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
August	6	Grasmere	3	pm	1730	0	0	0	0	5	0	0	2
Septemb	1	Pearson	5	am	700	2	1	0	0	0	12	0	0
Septemb	1	Pearson	4	am	730	1	0	1	0	0	0	0	2
Septemb	1	Pearson	3	am	800	0	0	2	0	0	0	0	2
Septemb	1	Pearson	2	am	830	2	0	1	0	2	0	2	0
Septemb	1	Pearson	1	am	900	0	0	0	0	1	4	6	0
Septemb	2	Pearson	5	pm	1600	4	1	1	0	2	42	3	0
Septemb	2	Pearson	2	pm	1630	0	0	0	0	0	0	3	0
Septemb	2	Pearson	3	pm	1700	2	0	0	0	0	0	0	1
Septemb	2	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
Septemb	2	Pearson	1	pm	1800	0	1	0	0	1	0	4	1
Septemb	3	Pearson	4	am	700	6	0	0	0	0	0	0	0
Septemb	3	Pearson	5	am	730	3	0	1	0	0	34	3	0
Septemb	3	Pearson	1	am	800	0	0	0	0	0	0	2	0
Septemb	3	Pearson	2	am	830	2	0	0	0	1	0	0	0
Septemb	3	Pearson	3	am	900	1	0	0	0	0	0	0	0
Septemb	4	Pearson	4	pm	1600	0	0	0	0	0	0	0	2
Septemb	4	Pearson	2	pm	1630	1	0	0	0	0	0	0	0
Septemb	4	Pearson	3	pm	1700	2	0	0	0	0	0	0	0
Septemb	4	Pearson	1	pm	1730	0	0	0	0	0	0	2	0
Septemb	4	Pearson	5	pm	1800	2	0	0	0	0	35	4	1
Septemb	1	Grasmere.	2	pm	1600	0	0	0	0	4	0	0	0
Septemb	1	Grasmere	3	pm	1630	0	0	0	0	0	49	0	3
Septemb	1	Grasmere	1	pm	1700	1	0	0	0	4	183	2	0
Septemb	1	Grasmere	4	pm	1730	0	0	0	0	2	0	1	0
Septemb	1	Grasmere	5	pm	1800	0	0	0	0	3	0	0	0
Septemb	2	Grasmere	2	am	700	0	0	0	0	0	3	0	2
Septemb	2	Grasmere	1	am	730	0	0	0	0	1	11	0	0
Septemb	2	Grasmere	4	am	800	0	0	0	0	2	24	0	0
Septemb	2	Grasmere	5	am	830	0	0	0	0	1	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
August	6	Grasmere	3	pm	1730	13	0	0	0	0	0	0	0
Septemb	1	Pearson	5	am	700	2	0	1	0	0	0	2	0
Septemb	1	Pearson	4	am	730	0	0	0	0	0	0	0	0
Septemb	1	Pearson	3	am	800	2	0	9	0	0	0	0	0
Septemb	1	Pearson	2	am	830	4	0	16	0	0	0	0	0
Septemb	1	Pearson	1	am	900	13	0	0	0	0	2	0	0
Septemb	2	Pearson	5	pm	1600	2	0	5	0	0	0	3	0
Septemb	2	Pearson	2	pm	1630	3	0	21	0	0	0	0	0
Septemb	2	Pearson	3	pm	1700	3	0	14	0	0	0	0	0
Septemb	2	Pearson	4	pm	1730	0	0	0	0	0	0	2	0
Septemb	2	Pearson	1	pm	1800	2	0	0	0	0	2	0	0
Septemb	3	Pearson	4	am	700	3	0	1	0	0	0	0	0
Septemb	3	Pearson	5	am	730	2	0	14	0	2	0	0	0
Septemb	3	Pearson	1	am	800	4	0	0	0	0	2	2	0
Septemb	3	Pearson	2	am	830	0	0	10	0	0	0	0	0
Septemb	3	Pearson	3	am	900	2	0	38	0	0	0	0	0
Septemb	4	Pearson	4	pm	1600	0	0	0	0	0	0	0	0
Septemb	4	Pearson	2	pm	1630	0	0	16	0	0	0	0	0
Septemb	4	Pearson	3	pm	1700	0	0	6	0	0	0	0	0
Septemb	4	Pearson	1	pm	1730	10	0	0	0	2	2	0	0
Septemb	4	Pearson	5	pm	1800	0	0	6	1	0	0	0	0
Septemb	1	Grasmere.	2	pm	1600	0	0	0	0	0	0	0	0
Septemb	1	Grasmere	3	pm	1630	0	8	0	0	2	0	0	0
Septemb	1	Grasmere	1	pm	1700	0	0	23	0	0	0	1	0
Septemb	1	Grasmere	4	pm	1730	0	0	0	0	0	0	0	0
Septemb	1	Grasmere	5	pm	1800	0	0	15	0	0	0	0	0
Septemb	2	Grasmere	2	am	700	0	0	0	0	0	0	0	0
Septemb	2	Grasmere	1	am	730	2	0	15	0	0	0	0	0
Septemb	2	Grasmere	4	am	800	0	0	0	0	0	0	0	0
Septemb	2	Grasmere	5	am	830	0	0	18	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
August	6	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
Septemb	1	Pearson	5	am	700	0	0	0	0	0	0	0	0
Septemb	1	Pearson	4	am	730	0	0	0	0	0	0	0	0
Septemb	1	Pearson	3	am	800	0	0	0	0	0	0	0	0
Septemb	1	Pearson	2	am	830	0	0	0	0	0	0	0	0
Septemb	1	Pearson	1	am	900	0	0	0	0	0	0	0	0
Septemb	2	Pearson	5	pm	1600	2	0	0	0	0	0	0	0
Septemb	2	Pearson	2	pm	1630	0	0	0	0	0	0	0	0
Septemb	2	Pearson	3	pm	1700	0	0	0	0	0	0	0	0
Septemb	2	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
Septemb	2	Pearson	1	pm	1800	0	0	0	0	0	0	0	0
Septemb	3	Pearson	4	am	700	2	0	0	0	0	0	0	0
Septemb	3	Pearson	5	am	730	0	0	0	0	0	0	0	0
Septemb	3	Pearson	1	am	800	0		0	0	0	0	0	0
Septemb	3	Pearson	2	am	830	0	0	0	0	0	0	0	0
Septemb	3	Pearson	3	am	900	0	0	0	0	0	0	0	0
Septemb	4	Pearson	4	pm	1600	0	0	0	0	0	0	0	0
Septemb	4	Pearson	2	pm	1630	0	0	0	0	0	0	0	0
Septemb	4	Pearson	3	pm	1700	0	0	0	0	0	0	0	0
Septemb	4	Pearson	1	pm	1730	0	0	0	0	0	0	0	0
Septemb	4	Pearson	5	pm	1800	0	0	0	0	0	0	0	0
Septemb	1	Grasmere.	2	pm	1600	0	0	0	0	0	0	0	0
Septemb	1	Grasmere	3	pm	1630	0	0	0	0	0	0	0	0
Septemb	1	Grasmere	1	pm	1700	0	0	0	0	0	0	0	0
Septemb	1	Grasmere	4	pm	1730	0	0	0	0	0	0	0	0
Septemb	1	Grasmere	5	pm	1800	0	0	0	0	0	0	0	0
Septemb	2	Grasmere	2	am	700	0	0	0	0	0	0	0	0
Septemb	2	Grasmere	1	am	730	0	0	0	0	0	0	0	0
Septemb	2	Grasmere	4	am	800	0	0	0	0	0	0	0	0
Septemb	2	Grasmere	5	am	830	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Septemb	2	Grasmere	3	am	900	0	0	0	0	3	81	3	2
Septemb	3	Grasmere	4	pm	1600	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	3	pm	1630	0	0	0	0	0	0	2	4
Septemb	3	Grasmere	5	pm	1700	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	2	pm	1730	0	0	0	0	5	0	0	0
Septemb	3	Grasmere	1	pm	1800	0	0	0	0	1	0	0	0
October	1	Pearson	5	am	730	3	0	0	0	1	16	8	0
October	1	Pearson	4	am	800	4	0	0	0	0	0	0	0
October	1	Pearson	1	am	830	0	0	0	0	2	9	8	2
October	1	Pearson	3	am	900	3	0	0	0	0	0	0	1
October	1	Pearson	2	am	930	1	0	0	0	0	0	0	0
October	2	Pearson	5	pm	1730	4	0	0	0	0	0	2	1
October	2	Pearson	3	pm	1800	1	0	0	0	0	0	0	0
October	2	Pearson	4	pm	1830	0	0	0	0	0	0	0	0
October	2	Pearson	1	pm	1900	0	0	0	0	4	4	5	0
October	2	Pearson	2	pm	1930	1	0	0	0	0	0	0	0
October	3	Pearson	1	pm	1730	0	0	0	0	2	2	2	1
October	3	Pearson	4	pm	1800	4	0	0	0	2	0	0	0
October	3	Pearson	2	pm	1830	2	0	0	0	3	0	0	0
October	3	Pearson	5	pm	1900	5	1	0	0	3	10	2	0
October	3	Pearson	3	pm	1930	0	0	0	0	2	0	0	0
October	4	Pearson	4	am	730	0	0	0	0	0	0	1	0
October	4	Pearson	5	am	800	5	0	0	0	0	3	4	0
October	4	Pearson	2	am	830	2	0	0	0	0	0	0	0
October	4	Pearson	1	am	900	0	0	0	0	2	2	4	0
October	4	Pearson	3	am	930	1	0	1	0	0	0	0	0
October	5	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
October	5	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
October	5	Pearson	1	pm	1830	0	0	0	0	3	23	2	2
October	5	Pearson	2	pm	1900	2	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Septemb	2	Grasmere	3	am	900	2	5	0	0	0	0	3	0
Septemb	3	Grasmere	4	pm	1600	0	0	16	0	0	0	0	0
Septemb	3	Grasmere	3	pm	1630	0	8	0	0	0	0	0	0
Septemb	3	Grasmere	5	pm	1700	0	0	11	0	0	0	0	0
Septemb	3	Grasmere	2	pm	1730	2	0	2	0	0	0	0	0
Septemb	3	Grasmere	1	pm	1800	0	0	0	0	0	0	0	0
October	1	Pearson	5	am	730	0	0	9	1	0	0	0	0
October	1	Pearson	4	am	800	0	0	0	0	0	0	0	0
October	1	Pearson	1	am	830	0	0	0	0	0	0	0	0
October	1	Pearson	3	am	900	0	0	16	0	0	0	0	0
October	1	Pearson	2	am	930	0	0	2	0	0	0	0	0
October	2	Pearson	5	pm	1730	0	0	0	0	0	0	0	0
October	2	Pearson	3	pm	1800	0	0	31	0	0	0	0	0
October	2	Pearson	4	pm	1830	0	0	6	0	0	0	0	0
October	2	Pearson	1	pm	1900	2	0	0	2	0	6	0	0
October	2	Pearson	2	pm	1930	0	0	9	0	0	0	0	0
October	3	Pearson	1	pm	1730	0	0	2	0	0	0	0	0
October	3	Pearson	4	pm	1800	0	0	0	0	0	0	0	0
October	3	Pearson	2	pm	1830	0	0	9	0	0	0	0	0
October	3	Pearson	5	pm	1900	0	0	3	2	2	0	1	0
October	3	Pearson	3	pm	1930	0	0	21	0	0	0	0	0
October	4	Pearson	4	am	730	0	0	0	0	0	0	1	0
October	4	Pearson	5	am	800	0	0	24	0	0	0	3	0
October	4	Pearson	2	am	830	0	0	4	0	0	0	0	0
October	4	Pearson	1	am	900	0	0	0	0	0	0	0	0
October	4	Pearson	3	am	930	2	0	10	0	0	0	0	0
October	5	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
October	5	Pearson	3	pm	1800	0	0	24	0	0	0	0	0
October	5	Pearson	1	pm	1830	4	0	4	1	2	1	0	0
October	5	Pearson	2	pm	1900	2	0	1	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Septemb	2	Grasmere	3	am	900	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	4	pm	1600	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	3	pm	1630	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	5	pm	1700	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	2	pm	1730	0	0	0	0	0	0	0	0
Septemb	3	Grasmere	1	pm	1800	0	0	0	0	0	0	0	0
October	1	Pearson	5	am	730	0	0	0	0	0	0	0	0
October	1	Pearson	4	am	800	0	0	0	0	0	0	0	0
October	1	Pearson	1	am	830	0	0	0	0	0	0	0	0
October	1	Pearson	3	am	900	0	0	0	0	0	0	0	0
October	1	Pearson	2	am	930	0	0	0	0	0	0	0	0
October	2	Pearson	5	pm	1730	0	0	0	0	0	0	0	0
October	2	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
October	2	Pearson	4	pm	1830	0	0	0	0	0	0	0	0
October	2	Pearson	1	pm	1900	0	0	0	0	0	0	0	0
October	2	Pearson	2	pm	1930	0	0	0	0	0	0	0	0
October	3	Pearson	1	pm	1730	0	0	0	0	0	0	0	0
October	3	Pearson	4	pm	1800	0	0	0	0	0	0	0	0
October	3	Pearson	2	pm	1830	0	0	0	0	0	0	0	0
October	3	Pearson	5	pm	1900	0	0	0	0	0	0	0	0
October	3	Pearson	3	pm	1930	0	0	0	0	0	0	0	0
October	4	Pearson	4	am	730	0	0	0	0	0	0	0	0
October	4	Pearson	5	am	800	0	0	0	0	0	0	0	0
October	4	Pearson	2	am	830	0	0	0	0	0	0	0	0
October	4	Pearson	1	am	900	0	0	0	0	0	0	0	0
October	4	Pearson	3	am	930	0	0	0	0	0	0	0	0
October	5	Pearson	4	pm	1730	0	0	0	0	0	0	0	0
October	5	Pearson	3	pm	1800	0	0	0	0	0	0	0	0
October	5	Pearson	1	pm	1830	0	0	0	0	0	0	0	0
October	5	Pearson	2	pm	1900	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
October	5	Pearson	5	pm	1930	3	0	0	0	0	1	0	0
October	6	Pearson	4	am	730	0	0	0	0	0	0	0	0
October	6	Pearson	3	am	800	4	0	0	0	0	0	0	0
October	6	Pearson	5	am	830	4	0	0	2	1	18	2	0
October	6	Pearson	1	am	900	0	0	0	0	1	0	2	0
October	6	Pearson	2	am	930	2	0	0	0	0	0	0	0
October	1	Grasmere	2	pm	1730	0	0	0	0	0	0	0	0
October	1	Grasmere	3	pm	1800	0	0	0	0	2	0	0	0
October	1	Grasmere	4	pm	1830	0	0	0	0	0	0	0	0
October	1	Grasmere	5	pm	1900	0	0	0	0	0	0	0	2
October	1	Grasmere	1	pm	1930	0	0	0	0	0	0	1	0
October	2	Grasmere	4	am	730	0	0	0	0	0	0	0	0
October	2	Grasmere	3	am	800	0	0	0	0	0	0	0	0
October	2	Grasmere	5	am	830	0	0	0	0	2	0	0	0
October	2	Grasmere	1	am	900	0	0	0	0	1	0	0	0
October	2	Grasmere	2	am	930	0	0	0	0	1	0	0	2
October	3	Grasmere	5	am	730	0	0	0	0	0	0	0	0
October	3	Grasmere	1	am	800	0	0	0	0	0	2	7	0
October	3	Grasmere	3	am	830	0	0	0	0	3	0	0	0
October	3	Grasmere	4	am	900	1	0	0	0	1	0	0	0
October	3	Grasmere	2	am	930	0	0	0	0	0	4	0	0
October	4	Grasmere	5	pm	1730	2	0	0	0	0	0	0	0
October	4	Grasmere	2	pm	1800	0	0	0	0	4	0	0	1
October	4	Grasmere	3	pm	1830	0	0	0	0	3	0	0	0
October	4	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
October	4	Grasmere	1	pm	1930	2	0	0	0	4	0	0	0
October	5	Grasmere	1	am	730	0	0	0	0	5	0	3	0
October	5	Grasmere	5	am	800	0	0	0	0	0	0	0	0
October	5	Grasmere	4	am	830	2	0	0	0	0	0	0	0
October	5	Grasmere	3	am	900	0	0	0	0	3	0	0	1

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
October	5	Pearson	5	pm	1930	0	0	2	2	0	0	7	0
October	6	Pearson	4	am	730	0	0	0	0	0	0	0	0
October	6	Pearson	3	am	800	3	0	7	0	0	0	0	0
October	6	Pearson	5	am	830	0	0	11	2	0	0	6	0
October	6	Pearson	1	am	900	1	0	0	0	0	0	1	0
October	6	Pearson	2	am	930	0	0	0	0	0	0	0	0
October	1	Grasmere	2	pm	1730	0	0	18	0	0	0	0	0
October	1	Grasmere	3	pm	1800	0	0	0	0	0	0	0	0
October	1	Grasmere	4	pm	1830	0	0	9	0	0	0	0	0
October	1	Grasmere	5	pm	1900	0	0	5	0	0	0	0	0
October	1	Grasmere	1	pm	1930	0	0	0	0	0	0	0	0
October	2	Grasmere	4	am	730	0	0	0	0	0	0	0	0
October	2	Grasmere	3	am	800	0	0	0	0	0	0	0	0
October	2	Grasmere	5	am	830	0	0	37	0	0	0	0	0
October	2	Grasmere	1	am	900	0	0	1	0	0	0	0	0
October	2	Grasmere	2	am	930	0	0	0	0	0	0	0	0
October	3	Grasmere	5	am	730	2	0	0	0	0	0	0	0
October	3	Grasmere	1	am	800	0	0	2	0	0	0	0	0
October	3	Grasmere	3	am	830	0	0	0	0	0	0	0	0
October	3	Grasmere	4	am	900	1	0	0	0	0	0	0	0
October	3	Grasmere	2	am	930	0	0	0	0	0	0	0	0
October	4	Grasmere	5	pm	1730	0	0	29	0	0	0	0	0
October	4	Grasmere	2	pm	1800	3	0	0	0	0	0	0	0
October	4	Grasmere	3	pm	1830	3	0	0	0	0	0	0	0
October	4	Grasmere	4	pm	1900	0	0	15	0	0	0	0	0
October	4	Grasmere	1	pm	1930	0	0	3	0	0	0	0	0
October	5	Grasmere	1	am	730	0	0	0	0	0	0	0	0
October	5	Grasmere	5	am	800	0	0	12	0	0	0	0	0
October	5	Grasmere	4	am	830	0	0	10	0	0	0	0	0
October	5	Grasmere	3	am	900	3	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
October	5	Pearson	5	pm	1930	0	0	0	0	0	0	0	0
October	6	Pearson	4	am	730	0	0	0	0	0	0	0	0
October	6	Pearson	3	am	800	0	0	0	0	0	0	0	0
October	6	Pearson	5	am	830	0	1	0	0	0	0	0	0
October	6	Pearson	1	am	900	0	0	0	0	0	0	0	0
October	6	Pearson	2	am	930	0	0	0	0	0	0	0	0
October	1	Grasmere	2	pm	1730	0	0	0	0	0	0	0	0
October	1	Grasmere	3	pm	1800	0	0	0	0	0	0	0	0
October	1	Grasmere	4	pm	1830	0	0	0	0	0	0	0	0
October	1	Grasmere	5	pm	1900	0	0	0	0	0	0	0	0
October	1	Grasmere	1	pm	1930	0	0	0	0	0	0	0	0
October	2	Grasmere	4	am	730	0	0	0	0	0	0	0	0
October	2	Grasmere	3	am	800	0	0	0	0	0	0	0	0
October	2	Grasmere	5	am	830	0	0	0	0	0	0	0	0
October	2	Grasmere	1	am	900	0	0	0	0	0	0	0	0
October	2	Grasmere	2	am	930	0	0	0	0	0	0	1	0
October	3	Grasmere	5	am	730	0	0	0	0	0	0	0	0
October	3	Grasmere	1	am	800	0	0	0	0	0	0	0	0
October	3	Grasmere	3	am	830	0	0	0	0	0	1	0	0
October	3	Grasmere	4	am	900	0	0	0	0	0	0	0	0
October	3	Grasmere	2	am	930	0	0	0	0	0	0	0	0
October	4	Grasmere	5	pm	1730	0	0	0	0	0	0	0	0
October	4	Grasmere	2	pm	1800	0	0	0	0	0	0	1	0
October	4	Grasmere	3	pm	1830	0	0	0	0	0	0	0	0
October	4	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
October	4	Grasmere	1	pm	1930	0	0	0	0	0	0	0	0
October	5	Grasmere	1	am	730	0	0	0	0	0	0	0	0
October	5	Grasmere	5	am	800	0	0	0	0	0	0	0	0
October	5	Grasmere	4	am	830	0	0	0	0	0	0	0	0
October	5	Grasmere	3	am	900	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
October	5	Grasmere	2	am	930	0	0	0	0	1	0	0	0
October	6	Grasmere	3	pm	1730	0	0	0	0	2	0	0	0
October	6	Grasmere	4	pm	1800	0	0	0	0	1	0	0	0
October	6	Grasmere	5	pm	1830	0	0	0	0	0	0	0	0
October	6	Grasmere	2	pm	1900	0	0	0	0	0	0	0	0
October	6	Grasmere	1	pm	1930	2	0	0	0	12	1	0	0
Novem	1	Pearson	1	am	600	0	0	0	0	1	2	2	0
Novem	1	Pearson	3	am	630	1	0	0	2	0	0	0	1
Novem	1	Pearson	4	am	700	1	1	0	0	0	0	0	0
Novem	1	Pearson	2	am	730	1	0	0	0	0	0	1	0
Novem	1	Pearson	5	am	800	3	0	0	1	2	15	8	0
Novem	2	Pearson	1	pm	1830	0	0	0	0	1	3	4	2
Novem	2	Pearson	3	pm	1900	3	0	0	0	0	0	0	0
Novem	2	Pearson	5	pm	1930	1	0	0	0	0	22	5	0
Novem	2	Pearson	4	pm	2000	0	0	0	0	0	0	0	0
Novem	2	Pearson	2	pm	2030	2	0	0	0	0	0	0	0
Novem	3	Pearson	1	pm	1830	0	0	0	0	0	0	4	0
Novem	3	Pearson	4	pm	1900	0	0	0	0	0	0	0	0
Novem	3	Pearson	5	pm	1930	2	0	0	0	0	0	0	0
Novem	3	Pearson	3	pm	2000	2	0	0	0	0	0	0	0
Novem	3	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Novem	4	Pearson	3	am	600	1	0	0	0	0	0	0	0
Novem	4	Pearson	5	am	630	3	0	0	0	0	0	3	0
Novem	4	Pearson	2	am	700	1	0	0	0	0	0	0	0
Novem	4	Pearson	4	am	730	0	0	0	0	0	0	0	0
Novem	4	Pearson	1	am	800	1	0	0	0	1	3	2	0
Novem	5	Pearson	1	am	600	1	0	0	0	1	2	0	0
Novem	5	Pearson	2	am	630	1	0	0	0	0	0	2	0
Novem	5	Pearson	3	am	700	2	0	0	0	0	0	0	0
Novem	5	Pearson	5	am	730	4	0	0	0	0	8	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
October	5	Grasmere	2	am	930	0	0	0	0	0	0	0	0
October	6	Grasmere	3	pm	1730	5	0	0	0	0	0	0	0
October	6	Grasmere	4	pm	1800	1	0	0	0	0	0	0	0
October	6	Grasmere	5	pm	1830	3	0	5	0	0	0	0	0
October	6	Grasmere	2	pm	1900	0	0	10	0	0	0	0	0
October	6	Grasmere	1	pm	1930	0	0	2	0	0	0	0	0
Novem	1	Pearson	1	am	600	0	0	0	0	0	0	0	0
Novem	1	Pearson	3	am	630	2	0	3	0	0	0	0	0
Novem	1	Pearson	4	am	700	0	0	0	0	0	0	0	0
Novem	1	Pearson	2	am	730	0	0	19	0	0	0	0	0
Novem	1	Pearson	5	am	800	0	0	0	1	2	0	0	0
Novem	2	Pearson	1	pm	1830	2	0	7	0	0	5	0	0
Novem	2	Pearson	3	pm	1900	0	0	1	0	0	0	0	0
Novem	2	Pearson	5	pm	1930	0	0	5	0	4	0	0	0
Novem	2	Pearson	4	pm	2000	0	0	0	0	0	0	0	0
Novem	2	Pearson	2	pm	2030	2	0	5	0	0	0	0	0
Novem	3	Pearson	1	pm	1830	0	0	0	0	0	0	0	0
Novem	3	Pearson	4	pm	1900	1	0	0	0	0	0	0	0
Novem	3	Pearson	5	pm	1930	0	0	1	0	0	0	0	0
Novem	3	Pearson	3	pm	2000	0	0	1	0	0	0	0	0
Novem	3	Pearson	2	pm	2030	0	0	10	0	0	0	0	0
Novem	4	Pearson	3	am	600	2	0	1	0	0	0	0	0
Novem	4	Pearson	5	am	630	5	0	2	0	0	0	0	0
Novem	4	Pearson	2	am	700	0	0	13	0	0	0	0	0
Novem	4	Pearson	4	am	730	2	0	0	0	0	0	0	0
Novem	4	Pearson	1	am	800	0	0	1	0	0	2	0	0
Novem	5	Pearson	1	am	600	0	0	2	0	0	1	0	0
Novem	5	Pearson	2	am	630	0	0	13	0	0	0	0	0
Novem	5	Pearson	3	am	700	0	0	2	0	0	0	0	0
Novem	5	Pearson	5	am	730	3	0	9	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
October	5	Grasmere	2	am	930	0	0	0	0	0	0	0	0
October	6	Grasmere	3	pm	1730	0	0	0	0	0	0	0	0
October	6	Grasmere	4	pm	1800	0	1	0	0	0	0	0	0
October	6	Grasmere	5	pm	1830	0	0	0	0	0	0	0	0
October	6	Grasmere	2	pm	1900	0	0	0	0	0	0	0	0
October	6	Grasmere	1	pm	1930	0	0	0	0	0	0	0	0
Novem	1	Pearson	1	am	600	0	0	0	0	0	0	0	0
Novem	1	Pearson	3	am	630	0	0	0	0	0	0	0	0
Novem	1	Pearson	4	am	700	0	0	0	0	0	0	0	0
Novem	1	Pearson	2	am	730	0	0	0	0	0	0	0	0
Novem	1	Pearson	5	am	800	0	0	0	0	0	0	0	0
Novem	2	Pearson	1	pm	1830	0	0	0	0	0	0	0	0
Novem	2	Pearson	3	pm	1900	0	0	0	0	0	0	0	0
Novem	2	Pearson	5	pm	1930	0	0	0	0	0	0	0	0
Novem	2	Pearson	4	pm	2000	0	0	0	0	0	0	0	0
Novem	2	Pearson	2	pm	2030	8	0	0	0	0	0	0	0
Novem	3	Pearson	1	pm	1830	0	0	0	0	0	0	0	0
Novem	3	Pearson	4	pm	1900	0	0	0	0	0	0	0	0
Novem	3	Pearson	5	pm	1930	0	0	0	0	0	0	0	0
Novem	3	Pearson	3	pm	2000	0	0	0	0	0	0	0	0
Novem	3	Pearson	2	pm	2030	3	0	0	0	0	0	0	0
Novem	4	Pearson	3	am	600	0	0	0	0	0	0	0	0
Novem	4	Pearson	5	am	630	0	0	0	0	1	0	0	0
Novem	4	Pearson	2	am	700	0	0	0	0	0	0	0	0
Novem	4	Pearson	4	am	730	0	0	0	0	0	0	0	0
Novem	4	Pearson	1	am	800	0	0	0	0	0	0	0	0
Novem	5	Pearson	1	am	600	0	0	0	0	0	0	0	0
Novem	5	Pearson	2	am	630	0	0	0	0	0	0	0	0
Novem	5	Pearson	3	am	700	0	0	0	0	0	0	0	0
Novem	5	Pearson	5	am	730	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Novem	5	Pearson	4	am	800	0	0	0	0	0	0	0	0
Novem	6	Pearson	3	pm	1830	0	0	0	0	0	0	0	0
Novem	6	Pearson	1	pm	1900	0	0	0	0	1	2	4	0
Novem	6	Pearson	5	pm	1930	4	0	0	0	0	0	0	0
Novem	6	Pearson	4	pm	2000	0	0	0	0	0	0	0	0
Novem	6	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Novem	1	Grasmere	3	pm	1830	0	0	0	0	23	0	0	3
Novem	1	Grasmere	4	pm	1900	0	0	0	0	14	0	0	0
Novem	1	Grasmere	2	pm	1930	0	0	0	0	14	0	0	2
Novem	1	Grasmere	1	pm	2000	0	0	0	0	3	0	0	0
Novem	1	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0
Novem	2	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Novem	2	Grasmere	1	am	630	0	0	0	0	11	0	1	2
Novem	2	Grasmere	2	am	700	0	0	0	0	12	0	0	0
Novem	2	Grasmere	3	am	730	0	0	0	0	28	0	0	1
Novem	2	Grasmere	4	am	800	0	0	0	0	6	0	0	0
Novem	3	Grasmere	1	am	600	0	0	0	0	5	1	4	0
Novem	3	Grasmere	3	am	630	0	0	0	0	0	0	0	0
Novem	3	Grasmere	5	am	700	0	0	0	0	0	0	0	0
Novem	3	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Novem	3	Grasmere	2	am	800	0	0	0	0	0	0	0	0
Novem	4	Grasmere	3	pm	1830	0	0	0	0	29	46	0	0
Novem	4	Grasmere	2	pm	1900	0	0	0	0	12	0	0	0
Novem	4	Grasmere	4	pm	1930	0	0	0	0	6	0	0	0
Novem	4	Grasmere	5	pm	2000	0	0	0	0	0	0	0	0
Novem	4	Grasmere	1	pm	2030	2	0	0	0	5	0	0	0
Novem	5	Grasmere	2	pm	1830	0	0	0	0	9	0	0	0
Novem	5	Grasmere	4	pm	1900	0	0	0	0	8	0	0	0
Novem	5	Grasmere	1	pm	1930	0	0	0	0	0	4	0	0
Novem	5	Grasmere	3	pm	2000	0	0	0	0	28	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Novem	5	Pearson	4	am	800	0	0	0	0	0	0	0	0
Novem	6	Pearson	3	pm	1830	0	0	0	0	0	0	0	0
Novem	6	Pearson	1	pm	1900	0	0	1	0	0	2	0	0
Novem	6	Pearson	5	pm	1930	0	0	0	0	0	0	0	0
Novem	6	Pearson	4	pm	2000	0	0	0	0	0	0	0	0
Novem	6	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Novem	1	Grasmere	3	pm	1830	3	0	0	0	1	0	1	0
Novem	1	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Novem	1	Grasmere	2	pm	1930	2	0	0	0	0	0	0	0
Novem	1	Grasmere	1	pm	2000	0	0	42	0	0	0	0	0
Novem	1	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0
Novem	2	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Novem	2	Grasmere	1	am	630	0	0	66	0	0	0	0	0
Novem	2	Grasmere	2	am	700	0	0	3	0	0	0	0	0
Novem	2	Grasmere	3	am	730	0	0	0	0	0	0	0	0
Novem	2	Grasmere	4	am	800	5	0	0	0	0	0	0	0
Novem	3	Grasmere	1	am	600	0	0	53	0	0	0	0	0
Novem	3	Grasmere	3	am	630	0	0	0	0	0	0	0	0
Novem	3	Grasmere	5	am	700	0	0	53	0	0	0	0	0
Novem	3	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Novem	3	Grasmere	2	am	800	0	0	0	0	0	0	0	0
Novem	4	Grasmere	3	pm	1830	1	0	0	0	0	0	0	0
Novem	4	Grasmere	2	pm	1900	0	0	0	0	0	0	0	0
Novem	4	Grasmere	4	pm	1930	0	0	0	0	0	0	0	0
Novem	4	Grasmere	5	pm	2000	0	0	19	0	0	0	0	0
Novem	4	Grasmere	1	pm	2030	0	0	20	0	0	0	0	0
Novem	5	Grasmere	2	pm	1830	0	0	0	0	0	0	0	0
Novem	5	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Novem	5	Grasmere	1	pm	1930	0	0	0	0	0	0	0	0
Novem	5	Grasmere	3	pm	2000	1	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Novem	5	Pearson	4	am	800	0	0	0	0	0	0	0	0
Novem	6	Pearson	3	pm	1830	0	0	0	0	0	0	0	0
Novem	6	Pearson	1	pm	1900	0	0	0	0	0	0	0	0
Novem	6	Pearson	5	pm	1930	0	0	0	0	0	0	0	0
Novem	6	Pearson	4	pm	2000	0	0	0	0	0	0	0	0
Novem	6	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Novem	1	Grasmere	3	pm	1830	0	0	0	0	0	0	0	0
Novem	1	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Novem	1	Grasmere	2	pm	1930	0	0	0	0	0	0	1	0
Novem	1	Grasmere	1	pm	2000	0	0	0	0	0	0	0	0
Novem	1	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0
Novem	2	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Novem	2	Grasmere	1	am	630	0	0	0	0	0	2	0	0
Novem	2	Grasmere	2	am	700	0	0	0	0	0	0	0	0
Novem	2	Grasmere	3	am	730	0	0	0	0	0	0	0	0
Novem	2	Grasmere	4	am	800	0	0	0	0	0	0	0	0
Novem	3	Grasmere	1	am	600	0	0	0	0	0	0	0	0
Novem	3	Grasmere	3	am	630	0	0	0	0	0	0	0	0
Novem	3	Grasmere	5	am	700	0	0	0	0	0	0	0	0
Novem	3	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Novem	3	Grasmere	2	am	800	0	0	0	0	0	0	0	0
Novem	4	Grasmere	3	pm	1830	0	0	0	0	0	0	1	0
Novem	4	Grasmere	2	pm	1900	0	0	0	0	0	0	0	0
Novem	4	Grasmere	4	pm	1930	0	0	0	0	0	0	0	0
Novem	4	Grasmere	5	pm	2000	0	0	0	0	0	0	0	0
Novem	4	Grasmere	1	pm	2030	0	0	0	0	0	0	0	0
Novem	5	Grasmere	2	pm	1830	0	0	0	0	0	0	0	0
Novem	5	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Novem	5	Grasmere	1	pm	1930	0	0	0	0	0	0	0	0
Novem	5	Grasmere	3	pm	2000	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Novem	5	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0
Novem	6	Grasmere	5	am	600	2	0	0	0	0	0	0	0
Novem	6	Grasmere	2	am	630	0	0	0	0	36	0	5	0
Novem	6	Grasmere	1	am	700	0	0	0	0	5	1	2	0
Novem	6	Grasmere	4	am	730	0	0	0	0	9	0	0	0
Novem	6	Grasmere	3	am	800	0	0	0	0	28	0	7	2
Dec	1	Pearson	2	pm	1900	0	0	0	0	0	0	0	0
Dec	1	Pearson	3	pm	1930	2	0	0	0	0	0	0	0
Dec	1	Pearson	5	pm	2000	1	0	0	0	0	0	7	0
Dec	1	Pearson	1	pm	2030	0	0	0	0	1	14	2	0
Dec	1	Pearson	4	pm	2100	0	0	0	0	0	0	0	0
Dec	2	Pearson	3	am	530	4	0	0	0	0	0	0	0
Dec	2	Pearson	2	am	600	5	0	0	0	0	0	2	0
Dec	2	Pearson	1	am	630	0	0	0	0	1	8	2	0
Dec	2	Pearson	4	am	700	3	0	0	0	0	0	0	0
Dec	2	Pearson	5	am	730	1	0	0	1	0	0	7	0
Dec	3	Pearson	3	am	530	2	0	0	0	0	0	0	0
Dec	3	Pearson	4	am	600	0	0	0	0	0	0	0	0
Dec	3	Pearson	1	am	630	0	0	0	0	0	0	0	0
Dec	3	Pearson	5	am	700	4	0	0	1	0	0	0	0
Dec	3	Pearson	2	am	730	5	0	0	0	0	0	0	0
Dec	4	Pearson	1	pm	1900	1	0	0	1	1	11	0	0
Dec	4	Pearson	5	pm	1930	5	0	0	0	0	0	9	0
Dec	4	Pearson	2	pm	2000	0	0	0	0	0	0	0	0
Dec	4	Pearson	4	pm	2030	0	0	0	0	0	0	0	0
Dec	4	Pearson	3	pm	2100	3	0	0	0	0	0	0	0
Dec	5	Pearson	4	pm	1900	2	0	0	0	0	0	0	0
Dec	5	Pearson	2	pm	1930	4	0	0	0	0	0	0	0
Dec	5	Pearson	1	pm	2000	0	0	0	0	1	13	7	0
Dec	5	Pearson	3	pm	2030	3	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Novem	5	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0
Novem	6	Grasmere	5	am	600	0	0	6	0	0	0	0	0
Novem	6	Grasmere	2	am	630	0	0	6	0	0	0	0	0
Novem	6	Grasmere	1	am	700	0	0	6	0	0	0	0	0
Novem	6	Grasmere	4	am	730	0	0	3	0	0	0	0	0
Novem	6	Grasmere	3	am	800	14	0	0	0	0	0	0	0
Dec	1	Pearson	2	pm	1900	0	0	0	0	0	0	0	0
Dec	1	Pearson	3	pm	1930	0	0	17	0	0	0	0	0
Dec	1	Pearson	5	pm	2000	0	0	0	0	0	0	1	0
Dec	1	Pearson	1	pm	2030	7	0	0	2	0	2	0	0
Dec	1	Pearson	4	pm	2100	0	0	0	0	0	0	0	0
Dec	2	Pearson	3	am	530	0	0	0	0	0	0	0	0
Dec	2	Pearson	2	am	600	0	0	20	2	0	0	0	0
Dec	2	Pearson	1	am	630	0	0	3	0	0	2	0	0
Dec	2	Pearson	4	am	700	8	0	0	0	0	0	0	0
Dec	2	Pearson	5	am	730	0	0	15	0	0	0	0	0
Dec	3	Pearson	3	am	530	0	0	3	0	0	0	0	0
Dec	3	Pearson	4	am	600	0	0	0	0	0	0	0	0
Dec	3	Pearson	1	am	630	0	0	2	0	0	4	0	0
Dec	3	Pearson	5	am	700	0	0	7	0	1	0	0	0
Dec	3	Pearson	2	am	730	2	0	4	0	0	0	0	0
Dec	4	Pearson	1	pm	1900	2	0	0	0	3	2	0	0
Dec	4	Pearson	5	pm	1930	5	0	4	0	0	0	1	0
Dec	4	Pearson	2	pm	2000	2	0	1	0	0	0	0	0
Dec	4	Pearson	4	pm	2030	0	0	0	0	0	0	0	0
Dec	4	Pearson	3	pm	2100	0	0	1	0	0	0	0	0
Dec	5	Pearson	4	pm	1900	0	0	1	0	0	0	0	0
Dec	5	Pearson	2	pm	1930	0	0	26	0	0	0	0	0
Dec	5	Pearson	1	pm	2000	2	0	6	1	3	0	0	0
Dec	5	Pearson	3	pm	2030	0	0	3	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Novem	5	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0
Novem	6	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Novem	6	Grasmere	2	am	630	0	0	0	0	0	1	0	0
Novem	6	Grasmere	1	am	700	0	0	0	0	0	0	0	0
Novem	6	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Novem	6	Grasmere	3	am	800	0	0	0	0	0	0	1	0
Dec	1	Pearson	2	pm	1900	0	0	0	0	0	0	0	0
Dec	1	Pearson	3	pm	1930	0	0	0	0	0	0	0	0
Dec	1	Pearson	5	pm	2000	0	0	0	0	0	0	0	0
Dec	1	Pearson	1	pm	2030	0	0	0	0	0	0	0	0
Dec	1	Pearson	4	pm	2100	0	0	0	0	0	0	0	0
Dec	2	Pearson	3	am	530	0	0	0	0	0	0	0	0
Dec	2	Pearson	2	am	600	0	0	0	0	0	0	0	0
Dec	2	Pearson	1	am	630	0	0	0	0	0	0	0	0
Dec	2	Pearson	4	am	700	0	0	0	0	0	0	0	0
Dec	2	Pearson	5	am	730	0	0	0	0	0	0	0	0
Dec	3	Pearson	3	am	530	0	0	0	0	0	0	0	0
Dec	3	Pearson	4	am	600	0	0	0	0	0	0	0	0
Dec	3	Pearson	1	am	630	0	0	0	0	0	0	0	0
Dec	3	Pearson	5	am	700	1	0	0	0	0	0	0	0
Dec	3	Pearson	2	am	730	1	0	0	0	0	0	0	0
Dec	4	Pearson	1	pm	1900	0	0	0	0	0	0	0	0
Dec	4	Pearson	5	pm	1930	0	0	0	0	0	0	0	0
Dec	4	Pearson	2	pm	2000	0	0	0	0	0	0	0	0
Dec	4	Pearson	4	pm	2030	0	0	0	0	0	0	0	0
Dec	4	Pearson	3	pm	2100	0	0	0	0	0	0	0	0
Dec	5	Pearson	4	pm	1900	0	0	0	0	0	0	0	0
Dec	5	Pearson	2	pm	1930	0	0	0	0	0	0	0	0
Dec	5	Pearson	1	pm	2000	0	0	0	0	0	0	0	0
Dec	5	Pearson	3	pm	2030	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Dec	5	Pearson	5	pm	2100	1	0	0	0	0	0	2	0
Dec	6	Pearson	5	am	530	2	0	0	0	0	0	0	0
Dec	6	Pearson	2	am	600	0	0	0	0	0	0	0	0
Dec	6	Pearson	4	am	630	0	0	0	0	0	0	0	0
Dec	6	Pearson	3	am	700	3	0	0	0	0	0	0	0
Dec	6	Pearson	1	am	730	0	0	0	0	1	5	2	0
Dec	1	Grasmere	3	am	530	0	0	0	0	43	2	0	0
Dec	1	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Dec	1	Grasmere	2	am	630	0	0	0	0	9	0	4	1
Dec	1	Grasmere	1	am	700	0	0	0	0	5	1	0	0
Dec	1	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Dec	2	Grasmere	3	pm	1900	0	0	0	0	33	0	0	0
Dec	2	Grasmere	5	pm	1930	0	0	0	0	4	0	0	0
Dec	2	Grasmere	1	pm	2000	2	0	0	0	5	0	0	0
Dec	2	Grasmere	4	pm	2030	0	0	0	0	2	0	0	0
Dec	2	Grasmere	2	pm	2100	0	0	0	0	6	0	0	0
Dec	3	Grasmere	3	pm	1900	0	0	0	0	58	12	3	0
Dec	3	Grasmere	2	pm	1930	0	0	0	0	14	19	0	0
Dec	3	Grasmere	5	pm	2000	0	0	0	0	0	0	0	0
Dec	3	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Dec	3	Grasmere	1	pm	2100	0	0	0	0	0	0	0	0
Dec	4	Grasmere	4	am	530	0	0	0	0	0	0	0	0
Dec	4	Grasmere	5	am	600	0	0	0	0	1	0	0	0
Dec	4	Grasmere	1	am	630	0	1	0	0	5	0	0	0
Dec	4	Grasmere	3	am	700	0	0	0	0	24	23	9	0
Dec	4	Grasmere	2	am	730	0	0	0	0	31	0	0	0
Dec	5	Grasmere	2	am	530	0	0	0	0	1	0	0	0
Dec	5	Grasmere	3	am	600	0	0	0	0	57	26	0	0
Dec	5	Grasmere	5	am	630	0	0	0	0	0	0	0	0
Dec	5	Grasmere	1	am	700	0	0	0	0	5	0	5	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Dec	5	Pearson	5	pm	2100	0	0	4	0	2	0	2	0
Dec	6	Pearson	5	am	530	0	0	0	0	0	0	1	0
Dec	6	Pearson	2	am	600	0	0	9	0	0	0	0	0
Dec	6	Pearson	4	am	630	0	0	0	0	0	0	0	0
Dec	6	Pearson	3	am	700	0	0	5	0	0	6	1	0
Dec	6	Pearson	1	am	730	0	0	0	0	0	3	0	0
Dec	1	Grasmere	3	am	530	4	0	0	0	0	0	0	0
Dec	1	Grasmere	5	am	600	5	0	30	0	0	0	0	0
Dec	1	Grasmere	2	am	630	0	0	17	0	0	0	0	0
Dec	1	Grasmere	1	am	700	0	0	11	0	0	0	0	0
Dec	1	Grasmere	4	am	730	0	0	4	0	0	0	0	0
Dec	2	Grasmere	3	pm	1900	0	0	0	0	0	0	0	0
Dec	2	Grasmere	5	pm	1930	5	0	4	0	0	0	0	0
Dec	2	Grasmere	1	pm	2000	6	0	32	0	0	0	0	0
Dec	2	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Dec	2	Grasmere	2	pm	2100	6	0	0	0	0	0	0	0
Dec	3	Grasmere	3	pm	1900	0	0	42	0	0	0	0	0
Dec	3	Grasmere	2	pm	1930	8	0	24	0	0	0	0	0
Dec	3	Grasmere	5	pm	2000	0	0	0	0	0	0	0	0
Dec	3	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Dec	3	Grasmere	1	pm	2100	0	0	1	0	0	0	0	0
Dec	4	Grasmere	4	am	530	0	0	0	0	0	0	0	0
Dec	4	Grasmere	5	am	600	0	0	24	0	0	0	0	0
Dec	4	Grasmere	1	am	630	0	0	33	0	0	0	0	0
Dec	4	Grasmere	3	am	700	0	0	0	0	0	0	0	0
Dec	4	Grasmere	2	am	730	0	0	0	0	0	0	0	0
Dec	5	Grasmere	2	am	530	1	0	32	0	0	0	0	0
Dec	5	Grasmere	3	am	600	0	0	0	0	0	0	0	0
Dec	5	Grasmere	5	am	630	0	0	0	0	0	0	0	0
Dec	5	Grasmere	1	am	700	0	0	1	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Dec	5	Pearson	5	pm	2100	0	0	0	0	0	0	0	0
Dec	6	Pearson	5	am	530	0	0	0	0	2	0	0	4
Dec	6	Pearson	2	am	600	0	0	0	0	0	0	0	0
Dec	6	Pearson	4	am	630	0	0	0	0	0	0	0	0
Dec	6	Pearson	3	am	700	0	0	0	0	0	0	0	0
Dec	6	Pearson	1	am	730	0	0	0	0	0	0	0	0
Dec	1	Grasmere	3	am	530	0	0	0	0	0	0	1	0
Dec	1	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Dec	1	Grasmere	2	am	630	0	0	0	0	0	0	0	0
Dec	1	Grasmere	1	am	700	0	0	0	0	0	0	0	0
Dec	1	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Dec	2	Grasmere	3	pm	1900	0	0	0	0	0	0	0	0
Dec	2	Grasmere	5	pm	1930	0	0	0	0	0	0	0	0
Dec	2	Grasmere	1	pm	2000	0	0	0	0	0	0	0	0
Dec	2	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Dec	2	Grasmere	2	pm	2100	0	0	0	0	0	0	1	0
Dec	3	Grasmere	3	pm	1900	0	0	0	0	0	0	0	0
Dec	3	Grasmere	2	pm	1930	0	0	0	0	0	0	1	0
Dec	3	Grasmere	5	pm	2000	0	0	0	0	0	0	0	0
Dec	3	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Dec	3	Grasmere	1	pm	2100	0	0	0	0	0	0	0	0
Dec	4	Grasmere	4	am	530	0	0	0	0	0	0	0	0
Dec	4	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Dec	4	Grasmere	1	am	630	0	0	0	0	0	3	0	0
Dec	4	Grasmere	3	am	700	0	0	0	0	0	0	0	0
Dec	4	Grasmere	2	am	730	0	0	0	0	0	0	0	0
Dec	5	Grasmere	2	am	530	0	0	0	0	0	2	0	0
Dec	5	Grasmere	3	am	600	0	0	0	0	0	0	0	0
Dec	5	Grasmere	5	am	630	0	0	0	0	0	0	0	0
Dec	5	Grasmere	1	am	700	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Dec	5	Grasmere	4	am	730	2	0	0	0	6	0	4	0
Dec	6	Grasmere	3	pm	1900	0	0	0	0	50	68	12	0
Dec	6	Grasmere	4	pm	1930	0	0	0	0	0	16	0	0
Dec	6	Grasmere	1	pm	2000	0	1	0	0	5	0	0	0
Dec	6	Grasmere	2	pm	2030	0	0	0	0	24	5	3	0
Dec	6	Grasmere	5	pm	2100	0	0	0	0	0	0	0	0
Jan	1	Pearson	5	pm	1830	6	0	0	0	0	0	0	8
Jan	1	Pearson	2	pm	1900	8	0	0	0	0	0	0	0
Jan	1	Pearson	4	pm	1930	0	0	0	0	0	0	0	3
Jan	1	Pearson	3	pm	2000	0	0	0	0	0	0	0	0
Jan	1	Pearson	1	pm	2030	0	0	0	0	0	0	4	14
Jan	2	Pearson	5	am	600	4	0	0	0	0	0	0	0
Jan	2	Pearson	4	am	630	0	0	0	0	0	0	0	0
Jan	2	Pearson	3	am	700	1	0	0	0	0	0	0	0
Jan	2	Pearson	1	am	730	0	0	0	0	0	0	0	0
Jan	2	Pearson	2	am	800	0	0	0	0	0	0	0	0
Jan	3	Pearson	2	pm	1830	5	0	0	0	0	0	0	0
Jan	3	Pearson	3	pm	1900	3	0	0	0	0	0	0	0
Jan	3	Pearson	5	pm	1930	2	1	0	0	0	0	0	0
Jan	3	Pearson	1	pm	2000	0	0	0	0	0	0	3	9
Jan	3	Pearson	4	pm	2030	6	0	0	0	0	0	0	0
Jan	4	Pearson	3	am	600	0	0	0	0	0	0	0	0
Jan	4	Pearson	5	am	630	1	0	0	0	0	0	0	0
Jan	4	Pearson	1	am	700	0	0	0	0	0	0	0	0
Jan	4	Pearson	4	am	730	0	0	0	0	0	0	0	0
Jan	4	Pearson	2	am	800	4	0	0	0	0	0	0	0
Jan	5	Pearson	1	pm	1830	1	0	0	1	2	0	0	0
Jan	5	Pearson	3	pm	1900	3	0	0	0	0	0	0	0
Jan	5	Pearson	4	pm	1930	0	0	0	0	0	0	0	0
Jan	5	Pearson	5	pm	2000	4	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Dec	5	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Dec	6	Grasmere	3	pm	1900	12	0	25	0	0	0	0	0
Dec	6	Grasmere	4	pm	1930	0	0	15	0	0	0	0	0
Dec	6	Grasmere	1	pm	2000	0	0	1	0	0	0	0	0
Dec	6	Grasmere	2	pm	2030	0	0	1	0	0	0	0	0
Dec	6	Grasmere	5	pm	2100	0	0	0	0	0	0	0	0
Jan	1	Pearson	5	pm	1830	0	0	20	0	0	0	2	0
Jan	1	Pearson	2	pm	1900	0	0	6	0	0	0	0	0
Jan	1	Pearson	4	pm	1930	0	0	0	0	0	0	0	0
Jan	1	Pearson	3	pm	2000	0	0	0	0	0	0	1	0
Jan	1	Pearson	1	pm	2030	0	0	17	1	1	4	0	0
Jan	2	Pearson	5	am	600	3	0	0	0	0	0	2	0
Jan	2	Pearson	4	am	630	0	0	0	0	0	0	0	0
Jan	2	Pearson	3	am	700	0	0	1	0	0	0	0	0
Jan	2	Pearson	1	am	730	3	0	0	0	0	0	0	0
Jan	2	Pearson	2	am	800	0	0	0	0	0	0	0	0
Jan	3	Pearson	2	pm	1830	0	0	3	0	0	0	1	0
Jan	3	Pearson	3	pm	1900	0	0	0	0	0	0	0	0
Jan	3	Pearson	5	pm	1930	5	0	25	0	0	0	5	0
Jan	3	Pearson	1	pm	2000	0	0	14	0	1	4	0	0
Jan	3	Pearson	4	pm	2030	0	0	2	0	0	0	0	0
Jan	4	Pearson	3	am	600	0	0	0	0	0	0	0	0
Jan	4	Pearson	5	am	630	1	0	0	0	0	4	0	0
Jan	4	Pearson	1	am	700	9	0	12	0	0	0	0	0
Jan	4	Pearson	4	am	730	0	0	0	0	0	0	0	0
Jan	4	Pearson	2	am	800	0	0	0	0	5	0	2	0
Jan	5	Pearson	1	pm	1830	15	0	7	0	0	0	0	0
Jan	5	Pearson	3	pm	1900	0	0	0	0	0	0	0	0
Jan	5	Pearson	4	pm	1930	0	0	0	0	0	0	0	0
Jan	5	Pearson	5	pm	2000	0	0	11	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Dec	5	Grasmere	4	am	730	0	0	0	0	0	0	0	0
Dec	6	Grasmere	3	pm	1900	0	0	0	0	0	0	1	0
Dec	6	Grasmere	4	pm	1930	0	0	0	0	0	0	0	0
Dec	6	Grasmere	1	pm	2000	0	0	0	0	0	0	0	0
Dec	6	Grasmere	2	pm	2030	0	0	0	0	0	0	0	0
Dec	6	Grasmere	5	pm	2100	0	0	0	0	0	0	0	0
Jan	1	Pearson	5	pm	1830	2	0	0	0	0	0	0	0
Jan	1	Pearson	2	pm	1900	0	0	0	0	0	0	0	0
Jan	1	Pearson	4	pm	1930	0	0	0	0	0	0	0	0
Jan	1	Pearson	3	pm	2000	0	0	0	0	0	0	0	0
Jan	1	Pearson	1	pm	2030	0	0	0	0	0	0	0	0
Jan	2	Pearson	5	am	600	0	0	0	0	0	0	0	0
Jan	2	Pearson	4	am	630	0	0	0	0	0	0	0	0
Jan	2	Pearson	3	am	700	0	0	0	0	0	0	0	0
Jan	2	Pearson	1	am	730	0	0	0	0	0	0	0	0
Jan	2	Pearson	2	am	800	0	0	0	0	0	0	0	0
Jan	3	Pearson	2	pm	1830	0	0	0	0	0	0	0	0
Jan	3	Pearson	3	pm	1900	0	0	0	0	0	0	0	0
Jan	3	Pearson	5	pm	1930	0	1	0	0	0	0	0	0
Jan	3	Pearson	1	pm	2000	0	0	0	0	0	0	0	0
Jan	3	Pearson	4	pm	2030	0	0	0	0	0	0	0	0
Jan	4	Pearson	3	am	600	0	0	0	0	0	0	0	0
Jan	4	Pearson	5	am	630	0	0	0	1	0	0	0	0
Jan	4	Pearson	1	am	700	0	0	0	0	0	0	0	0
Jan	4	Pearson	4	am	730	0	0	0	0	0	0	0	0
Jan	4	Pearson	2	am	800	0	0	0	0	0	0	0	0
Jan	5	Pearson	1	pm	1830	0	0	0	0	0	0	0	0
Jan	5	Pearson	3	pm	1900	0	0	0	0	0	0	0	0
Jan	5	Pearson	4	pm	1930	0	0	0	0	0	0	0	0
Jan	5	Pearson	5	pm	2000	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Jan	5	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Jan	6	Pearson	1	am	600	4	0	0	0	3	0	4	0
Jan	6	Pearson	5	am	630	8	1	0	1	0	0	0	0
Jan	6	Pearson	3	am	700	0	0	0	0	0	0	0	0
Jan	6	Pearson	4	am	730	1	0	0	0	0	0	0	0
Jan	6	Pearson	2	am	800	13	0	0	0	0	0	0	0
Jan	1	Grasmere	5	am	600	2	0	0	0	0	0	0	0
Jan	1	Grasmere	3	am	630	0	0	0	0	1	54	120	3
Jan	1	Grasmere	4	am	700	0	0	0	0	0	118	61	0
Jan	1	Grasmere	2	am	730	0	0	0	0	15	145	13	0
Jan	1	Grasmere	1	am	800	0	0	0	0	63	27	4	0
Jan	2	Grasmere	2	pm	1830	0	0	0	0	23	98	214	0
Jan	2	Grasmere	4	pm	1900	0	0	0	0	0	21	29	0
Jan	2	Grasmere	5	pm	1930	2	0	0	0	0	0	15	0
Jan	2	Grasmere	3	pm	2000	0	0	0	0	3	37	130	0
Jan	2	Grasmere	1	pm	2030	1	1	0	0	31	62	87	0
Jan	3	Grasmere	4	am	600	0	0	0	0	0	0	0	0
Jan	3	Grasmere	2	am	630	0	0	1	2	28	29	531	0
Jan	3	Grasmere	5	am	700	0	0	0	0	5	0	56	0
Jan	3	Grasmere	3	am	730	0	0	0	0	0	17	18	0
Jan	3	Grasmere	1	am	800	0	0	0	0	30	56	7	0
Jan	4	Grasmere	3	pm	1830	0	0	0	0	6	1	43	0
Jan	4	Grasmere	1	pm	1900	0	0	0	0	32	38	69	2
Jan	4	Grasmere	5	pm	1930	0	0	0	0	0	0	0	0
Jan	4	Grasmere	2	pm	2000	0	0	0	0	44	13	224	0
Jan	4	Grasmere	4	pm	2030	0	0	0	0	0	0	8	0
Jan	5	Grasmere	1	am	600	2	0	0	0	7	10	10	1
Jan	5	Grasmere	2	am	630	0	0	0	0	43	37	281	0
Jan	5	Grasmere	5	am	700	0	0	0	0	0	0	56	0
Jan	5	Grasmere	4	am	730	0	1	0	0	0	15	110	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Jan	5	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Jan	6	Pearson	1	am	600	0	0	12	0	0	1	0	0
Jan	6	Pearson	5	am	630	0	0	13	0	3	0	8	0
Jan	6	Pearson	3	am	700	0	0	0	0	0	0	2	0
Jan	6	Pearson	4	am	730	0	0	0	0	0	0	8	0
Jan	6	Pearson	2	am	800	0	0	2	0	0	0	0	0
Jan	1	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Jan	1	Grasmere	3	am	630	0	0	34	0	0	2	0	0
Jan	1	Grasmere	4	am	700	0	0	30	0	0	0	0	0
Jan	1	Grasmere	2	am	730	0	0	5	0	1	1	0	0
Jan	1	Grasmere	1	am	800	5	0	0	0	0	0	0	0
Jan	2	Grasmere	2	pm	1830	0	0	34	0	0	0	0	0
Jan	2	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Jan	2	Grasmere	5	pm	1930	0	0	2	0	0	0	0	0
Jan	2	Grasmere	3	pm	2000	0	0	108	0	0	0	0	0
Jan	2	Grasmere	1	pm	2030	1	0	2	0	0	0	0	0
Jan	3	Grasmere	4	am	600	17	0	0	0	0	0	0	0
Jan	3	Grasmere	2	am	630	3	0	0	0	0	0	0	0
Jan	3	Grasmere	5	am	700	0	0	18	0	0	0	0	0
Jan	3	Grasmere	3	am	730	0	0	0	0	0	0	0	0
Jan	3	Grasmere	1	am	800	5	0	0	0	0	0	2	0
Jan	4	Grasmere	3	pm	1830	2	0	13	0	0	0	0	0
Jan	4	Grasmere	1	pm	1900	0	0	0	0	0	0	0	0
Jan	4	Grasmere	5	pm	1930	0	0	0	0	0	0	0	0
Jan	4	Grasmere	2	pm	2000	2	0	30	0	0	0	0	0
Jan	4	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Jan	5	Grasmere	1	am	600	0	0	21	0	0	0	0	0
Jan	5	Grasmere	2	am	630	3	0	21	0	0	0	0	0
Jan	5	Grasmere	5	am	700	0	0	5	0	0	0	0	0
Jan	5	Grasmere	4	am	730	0	0	0	0	0	0	1	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Jan	5	Pearson	2	pm	2030	0	0	0	0	0	0	0	0
Jan	6	Pearson	1	am	600	0	0	0	0	0	0	0	0
Jan	6	Pearson	5	am	630	0	0	0	0	0	0	0	5
Jan	6	Pearson	3	am	700	0	0	0	0	0	0	0	0
Jan	6	Pearson	4	am	730	0	0	0	0	0	0	0	0
Jan	6	Pearson	2	am	800	0	0	0	0	0	0	0	0
Jan	1	Grasmere	5	am	600	0	0	0	0	0	0	0	0
Jan	1	Grasmere	3	am	630	0	0	0	0	0	0	1	0
Jan	1	Grasmere	4	am	700	0	0	0	0	0	0	0	0
Jan	1	Grasmere	2	am	730	0	0	0	0	0	0	0	0
Jan	1	Grasmere	1	am	800	0	0	0	0	0	0	0	0
Jan	2	Grasmere	2	pm	1830	0	0	0	0	0	0	0	0
Jan	2	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Jan	2	Grasmere	5	pm	1930	0	0	0	0	0	0	0	0
Jan	2	Grasmere	3	pm	2000	0	0	0	0	0	0	0	0
Jan	2	Grasmere	1	pm	2030	0	0	0	0	0	0	0	0
Jan	3	Grasmere	4	am	600	0	0	0	0	0	0	0	0
Jan	3	Grasmere	2	am	630	0	0	0	0	0	0	0	0
Jan	3	Grasmere	5	am	700	0	0	0	0	0	0	0	0
Jan	3	Grasmere	3	am	730	0	0	0	0	0	0	0	0
Jan	3	Grasmere	1	am	800	0	0	0	0	0	0	0	0
Jan	4	Grasmere	3	pm	1830	0	0	0	0	0	0	0	0
Jan	4	Grasmere	1	pm	1900	0	0	0	0	0	0	0	0
Jan	4	Grasmere	5	pm	1930	0	0	0	0	0	0	0	0
Jan	4	Grasmere	2	pm	2000	0	0	0	0	0	0	1	0
Jan	4	Grasmere	4	pm	2030	0	0	0	0	0	0	0	0
Jan	5	Grasmere	1	am	600	0	0	0	0	0	1	0	0
Jan	5	Grasmere	2	am	630	0	0	0	0	0	0	0	0
Jan	5	Grasmere	5	am	700	0	0	0	0	0	0	0	0
Jan	5	Grasmere	4	am	730	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	cregre	blshag	litshag	wfhern	blswan	cangse	pardk	mallard
Jan	5	Grasmere	3	am	800	0	8	0	0	5	0	121	3
Jan	6	Grasmere	1	pm	1830	0	0	0	0	17	59	64	3
Jan	6	Grasmere	4	pm	1900	0	0	0	0	0	90	48	0
Jan	6	Grasmere	2	pm	1930	0	0	0	0	22	0	114	0
Jan	6	Grasmere	3	pm	2000	0	0	0	0	6	0	34	0
Jan	6	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	greydk	mghybd	scaup	sipo	swplvr	pdstilt	blbagl	blbigl
Jan	5	Grasmere	3	am	800	0	0	0	0	0	4	0	0
Jan	6	Grasmere	1	pm	1830	0	0	5	0	0	0	0	0
Jan	6	Grasmere	4	pm	1900	2	0	62	0	0	0	0	0
Jan	6	Grasmere	2	pm	1930	0	0	0	0	0	0	0	0
Jan	6	Grasmere	3	pm	2000	0	0	9	0	0	0	0	0
Jan	6	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0

Appendix A

month	day	lake	site	am/pm	time	blfrtern	harrhk	falcon	magpie	nzpipit	shoveler	egoose	bandot
Jan	5	Grasmere	3	am	800	0	0	0	0	0	0	1	0
Jan	6	Grasmere	1	pm	1830	0	0	0	0	0	2	0	0
Jan	6	Grasmere	4	pm	1900	0	0	0	0	0	0	0	0
Jan	6	Grasmere	2	pm	1930	0	0	0	0	0	0	1	0
Jan	6	Grasmere	3	pm	2000	0	0	0	0	0	0	0	0
Jan	6	Grasmere	5	pm	2030	0	0	0	0	0	0	0	0

4.4 Total Counts

To obtain population estimates, particularly of the more mobile and widespread species, a 'Total Count' was made of the main study area during one day in each season (27 January, 6 April, 26 July, 5 October). During these counts S.1-10, D,B,M and MP were covered on foot while S.11-15 were viewed from a boat using five additional observers from the Wildlife Service and Wellington Acclimatisation Society. These observers counted the birds but did not record their habitat use.

4.5 Profiles

Eleven profiles were drawn of transects from the shore-line into the lake as shown on the vegetation map (map pocket). These profiles illustrate the vertical structure of the lake shore (Fig. 3). The site for each profile was chosen to obtain a representative transect of part of the shore while allowing easy access. Profiles were surveyed for each eastern shore section and in three western shore sites on 15-16 June 1983 (S.1,2,3,5,7) and 15-16 November 1983 (S.4,6,10,13a,13b,15). Distances and levels were measured with a surveying level and staff.

4.6 Describing Habitat Use By Wetland Birds

Use of the habitat is an important part of a species' niche, as described in report section 1.5.

The method for the quantification of the habitat use of wetland birds used on the Ahuriri River (Robertson et al. 1983) was observed there by P.J. Moore in early November 1982. Field testing of the method employed was conducted at Lake Wairarapa from 22-29 November 1982. The prototype method, as described by Robertson et al. (1983), was modified (as outlined below) to suit the different features of the Lake Wairarapa wetlands.

Habitat Classification

The habitat classification technique makes it possible to quantify the habitat use of wetland birds involved in different activities. Birds are not only counted but their observed use of specific habitat types is recorded in one of three activity categories, as follows;

a) Roosting, loafing and washing
b) Feeding and foraging - including aerial foraging where this could be identified
c) Breeding - presence of nest.

Birds that are flying by, disturbed by the observer or heard calling, are counted, but habitat classification is not possible.

The activity of each bird or group of birds and the habitat in which they are first seen are recorded; for rarely-encountered species the range of habitats used is recorded over a longer period, usually up to 10 minutes. The habitat classification describes an approximate point on the wetland using a combinatio of six categories, each with coded criteria. This differs from describing an exact point where an action is observed, as done by Robertson et al. (1983), since many observations at Lake Wairarapa were made at too great a distance for that degree of certainty. A full list of coded criteria is given by Robertson et al. (1983), although the code order differs here to group related criteria for graphing purposes. The interpretation of criteria also differs since, without producing many more codes, the existing criteria were used to accommodate the features peculiar to the Lake Wairarapa wetlands. The criteria used in this study are listed below. The definitions given include differences from those presented by Robertson et al. (1983).

Potentially, because of the subjectivity of this method, features of the wetlands could be described using different combinations of criteria. However, in this study all the habitat use data were collected by one observer, a procedure which minimised variability from this source.

Category 1: Wetland Type

W20 Lake - freshwater

This criterion was used to identify all parts of the Lake Wairarapa wetlands (Fig. 2).

Category 2: Location on Wetland

(01) Surrounding catchment - area outside the direct influence of the wetland or outside the study area. Usually refers to areas of developed farmland.

(03) River terrace

(05) Stopbank/groyne - man-made banks.

(06) Small bank - edge of natural bank of river, channel or lake edge.

(08) Low flood terrace - low-lying land adjacent to the lake shore.

(09) Bar/flat/spit - flats of the lake shore or ponds with at least one side of the feature adjacent to the water mass. Narrow flats, usually less than 50m, or frequently flooded zones. Flats may be bare or vegetated, usually by plants less than 15cm tall.

(20) Wetland flat - wide (usually greater than 50m), vegetated lake flats which are rarely completely submerged. Also describes pond margins that are vegetated by tall plants.

(12) Major channel, unbroken pool/run - rivers, former rivers (e.g., Ruamahanga Cut-off) and channels among the lake flats, usually wider than 15-25m.

(13) Small channel, unbroken pool/run - streams, drains and small lake channels, usually less than 15m wide.

(14) Dry water-course

(16) Backwater - bodies of water sheltered by adjacent lake flats and connected to the lake at one end.

(17) Disconnected pool - disconnected backwater or area of transitory water.

(18) Open water - main water mass of pond or lake.

(19) Edge water - relates approximately to feeding zone for waders or ducks (i.e., water less than 20cm deep) or water relatively close to the vegetated margin (distance varies depending on water mass size and structure).

Category 3: Habitat Description - describes the type of cover on the previously identified 'location'

A10 Human construction - general category for man-made structures, including transmission lines and bridges.

A11 Fence/post - includes maimais.

A18 Earthworks - includes unvegetated earth banks of excavated ponds.

A19 Road

A20 Flood debris - dead trees, branches and vegetation left by floods and high water levels.

A22 Fallen log

A23 Dead tree

A30 Bare ground

A31 Bare ground and sparse vegetation - very scattered vegetation (less than 20% ground cover), not including marsh and swamp vegetation (A41-49).

A41 Native turf <5 cm - small native plants, usually less than 5cm tall, which form mats ranging from dense turf to sparse, but identifiable, cover.

A42 Short rushes <15 cm - short rushes, usually less than 15cm tall, predominantly jointed-leaved rush. Often covers large areas of flats. (N.B. A list of common and formal names of plants is given in Appendix 5.)

A43 Tall rushes <50 cm - tall rushes, such as jointed rush and wiwi, or sedges of similar height and habitat, such as club rush and Purua grass. Small areas of lake or pond margins.

A44 Sedges - short sedges, such as three-square, which cover areas of flats.

A45 Mixed dicotyledonous herbs - herbs, such as water purslane, which often form monocultures in ponds and on their margins.

A46 Swamp grasses - grasses, such as Mercer grass and floating sweetgrass, which fill some ponds. Also includes other monocotyledonous herbs, such as water plantain.

A47 Tussock Carex - sedges of clumped or tussock-like habitat which are found in swamp margins. Common examples are cutty grass and grass sedge.

A48 Flax - New Zealand flax.

A49 Raupo

A61 Ploughed land - including new crop or pasture, burnt crops and stubble.

A62 Grain crops

A66 Grazed pasture

A69 Ungrazed grassland - rank grasses that are apparently not grazed by stock.

A70 Trees - general category for trees such as *Pinus radiata*, macrocarpa and cabbage tree.

A71 Willow - predominantly crack willow.

A80 Water - open water with no apparent subsurface aquatic vegetation or algae.

A81 Water and subsurface algae and/or aquatic vegetation - Lake vegetation includes horse's mane weed, submerged but unidentified marsh vegetation and algae. This criterion was always used for pond water where the subsurface vegetation was unknown.

A82 Water and floating surface vegetation - such as floating water-fern.

A83 Combined water category

Category 4: Substrate

The predominant surface substrate underlying the 'habitat' previously described.

0 Unknown - substrate uncertain or unrecorded.
1 Dry soil
2 Wet soil
4 Mud
5 Dry sand
6 Wet sand
7 Shingle - coarse substrate, stones 1-6 cm diameter.
8 Cobbles - large stones 6-20 cm diameter.

Water Classification

Water classification is used when birds are feeding or roosting in or over water, including areas of submerged or emergent marsh, swamp and pasture.

Category 5: Water speed/depth

B10 Saturated - substrate soaked but little or no surface water is present.

B11 Surface film <1 cm

B21 Static permanent - 1-8 cm - a body of water which is essentially both static and permanent, such as a lake, pond or channel of no apparent flow, between 1 and 8 centimetres deep.

B22 Static permanent - 8-16 cm

B23 Static permanent - >16 cm

B41 Slow 1-8 cm - water moving slowly in a channel.

B42 Slow 8-16 cm

B43 Slow >16 cm

Category 6: Water Colour/Width

Width is the distance across the water body that the bird is in or over. Small embayments on the lake shore are measured across their width (parallel to the shore). This category is not used for an area of emergent vegetation unless at the edge of a water body.

11 Clear <3 m
12 Clear 3-10 m
13 Clear 10-50 m
14 Clear 50-100 m
15 Clear >100 m

21 Milky <3 m - refers to turbid water in which vegetation or substrate bottom can still be seen.
22 Milky 3-10 m
23 Milky 10-50 m
24 Milky 50-100 m
25 Milky >100 m

31 Dirty <3 m
32 Dirty 3-10 m
33 Dirty 10-50 m
34 Dirty 50-100 m
35 Dirty >100 m

At least three and up to five codes are used for each bird or group of birds in the same habitat depending on the presence and nature of water.

e.g. location habitat substrate

(09) A30 - 6

In this case the bird was on a bare sandflat.

e.g., location habitat substrate

(18) A80 - 6
B23 - 35

water speed/depth water colour/width

In this case the bird was in still open water which was greater than 16cm deep, dirty, wider than 100m and over sand.

Appendix C

HABITAT CLASSIFICATION DATA

Data is mean numbers of birds utilising various habitat types for feeding and resting.

LAKE PEARSON

WATERFOWL- FEEDING

Month	ow+av	ow-av	ow, cd.cty	sw	l.edge	mudflat	fld.tce
March	2	0	2	1.5	0	0	0
April	0	5	38	6	0	0	0
May	2	6	0	33.2	3.3	8.8	0
June	2	7.3	0	25.5	1.8	4.8	1
Aug	0	3	9	0	0	2	0
Sept	7.2	0	11.1	3	4.9	0	0
Oct	3.5	2	11	2.1	3.5	23	0
Nov	2.4	2	5.2	2.16	0.5	0	11
Dec	6	0	3.6	7	0	2	3
Jan	6.1	0	13	7.5	1.1	1.5	0

WATERFOWL-RESTING

Month	ow+av	ow-av	ow, cdcty	sw	l.edge	mudflat	fld.tce
March	18.9	10.5	4	9.5	0	17	75
April	0	21	16.3	8	0	4	27
May	2	15.7	8	9.3	7	5.5	0
June	0	9.5	0	18.3	3.8	12	44.5
Aug	1.5	5.5	16.3	6	2.25	0	0
Sept	3.2	2.8	11.7	4.5	0	1.5	0
Oct	5.7	2.25	24	3.5	0.8	0	0
Nov	4.2	1.5	1	6	1.3		2
Dec	3.6	4	8.5	1	1	0	0
Jan	5	5	0	2.7	0.6	0	0

WADERS- FEEDING

Month	sw+av	l.edm	l.edpe	mudflat	fld.tce
March	0	2	2	3	0
April	0	0	2	2	0
May	0	0	2	0	0
June	0	2	0	0	0
Aug	0	1	0	0	0
Sept	0	2	0	2.5	0
Oct	1.5	1.6	0	3.5	0
Nov	2.5	0	1.5	0	1
Dec	2.3	3	2	0	0
Jan	2.8	1	1	0	0

Appendix C

WADERS-RESTING							
Month	sw+av	l.edm	l.edpe	mudflat	fld.tce		
March	0	0	3	0	0		
April	0	0	0	0	0		
May	0	0	6	2	2		
June	0	0	1.5	0	0		
Aug	0	0	0	0	0		
Sept	1.7	0	0	0	0		
Oct	0	0	0	2	0		
Nov	0	0	0	0	0		
Dec	2.6	0	3	2.5	1.5		
Jan	0	0	3	0	0		
SHAGS- FEEDING							
Month	ow,+av	ow,-av	ow,cd.cty	ow,fp	l.edge		
March	1	1	0	1	2		
April	0	0	0	1	0		
May	0	2	1.8	0	0		
June	0	1.1	0	0	0		
Aug	0	1	0	0	0		
Sept	0	0	0	0	0		
Oct	1	0	0	0	0		
Nov	0	0	0	0	0		
Dec	0	0	0	0	0		
Jan	0	0	0	0	0		
SHAGS-RESTING							
Month	ow,+av	ow-av	ow,cd.cty	ow,fp	l.edge		
March	0	3	0	2	3		
April	0	0	0	5	0		
May	0	2	1	1.8	1		
June	0	1.5	0	0	4.8		
Aug	0	0	0	1.5	1		
Sept	0	0	0	1	1.7		
Oct	0	0	0	1	1.5		
Nov	0	0	0	0	0		
Dec	0	0	0	0	0		
Jan	1	0	0	0	0		
GREBE-FEEDING							
Month	ow,cd.cty	ow+av					
March	2	2					
April	0	1					
May	0	0					
June	0	0					
Aug	1.6	0					
Sept	2	2					
Oct	2.5	1.8					
Nov	0	1.6					
Dec	1	3.7					
Jan	3.5	4					

Appendix C

GREBE-RESTING							
Month	ow-av	ow,cd.cty	ow+av	ow-av			
March	3.8	3.8	0	2			
April	2.5	4	0	0			
May	1.8	0	0	1.5			
June	1	0	0	1.5			
Aug	1.4	1	0	2.2			
Sept	5	1.8	0	1			
Oct	2.3	3	1.3	2.25			
Nov	1.5	2	1.3	1.5			
Dec	2	0	2.25	2.4			
Jan	3	4	1.7	1			
HERONS-FEEDING							
Month	sw+av	l.edm	l.edpe	mudflat			
Mar	1.5	0	1.3	0			
April	1	0	1	0			
May	0	0	0	0			
June	0	0	0	0			
Aug	0	0	0	0			
Sept	0	0	0	0			
Oct	0	0	0	0			
Nov	0	0	0	0			
Dec	0	0	0	0			
Jan	1	0	0	0			
HERONS-RESTING							
Month	sw+av	l.edm	l.edpe	mudflat			
Mar	1	0	1	0			
April	0	0	0	0			
May	0	0	0	0			
June	0	0	0	0			
Aug	0	0	0	0			
Sept	0	0	0	0			
Oct	0	0	0	0			
Nov	0	0	0	0			
Dec	0	0	0	0			
Jan	0	0	0	0			
GULLS & TERNS-FEEDING							
Month	ow+av	ow-av					
Mar	0	0					
April	0	0					
May	0	0					
June	0	0					
Aug	0	0					
Sept	0	3					
Oct	0	0					
Nov	5.5	0					
Dec	0	0					
Jan	0	6					

Appendix C

GULLS & TERNS-RESTING							
Month	ow+av	ow-av					
Mar	0	0					
April	0	0					
May	0	0					
June	0	0					
Aug	0	1.5					
Sept	0	1					
Oct	0	2					
Nov	0	0					
Dec	0	0					
Jan	0	3					

Appendix C

HABITAT CLASSIFICATION DATA

Data is mean number of birds utilising various habitat types for feeding and resting.

LAKE GRASMERE

WATERFOWL-FEEDING

Month	ow+av	ow-av	ow,cd.cty	sw, cd.cty	bank	swamp
Mar	16.1	0	0	0	0	0
April	11.12	19	0	5	0	0
May	15.3		8.3	0	0	0
June	19.9	18.3	8.4	6.7	0	0
Aug	4.16	8	3.5	4	0	0
Sept	6.2	0	1	9	0	0
Oct	2.9	0	0	3	2	0
Nov	9.8	0	0	2	0	0
Dec	14.6	2	0	1	0	0
Jan	22.9	0	30	5.8	4	0

WATERFOWL-RESTING

Month	ow+av	ow-av	ow, cd.cty	sw,cd.cty	bank	swamp
Mar	22.4	0	0	0	0	0
April	18.3	14	0	8	7	0
May	52.3	24.2	25.5	44	29	0
June	65.8	60.2	18	21.2	8.4	0
Aug	31.8	13.2	5	14	5.7	0
Sept	23.4	9.6	18	6.5	2	0
Oct	7.9	2	0	1	9	7
Nov	13.9	0	0	1.3	6.3	0
Dec	10.4	14.5	20	2	4.3	0
Jan	49.3	90	12.7	8.3	46.4	16.5

WADERS- FEEDING

Month	sw,cd.cty	l.edge	fld.tce	bank
Mar	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
Aug	0	0	0	0
Sept	0	0	0	0
Oct	0	0	0	0
Nov	0	0	0	0
Dec	0	0	0	0
Jan	1.6	7	0	0

Appendix C

WADERS-RESTING						
Month	sw,cd.cty	l.edge	fld.tce	bank		
Mar	0	3	0	0		
April	0	0	0	0		
May	0	0	0	0		
June	0	0	0	0		
Aug	0	0	0	0		
Sept	0	2	0	0		
Oct	0	0	0	0		
Nov	0	0	0	0		
Dec	0	0	0	0		
Jan	0	0	0	0		
SHAGS-FEEDING						
Month	ow+av	ow-av	ow,cd.cty	ow,fp	l.edge	
Mar	1	0	0	0	0	
April	1	1	0	0	0	
May	1	0	0	0	0	
June	0	0	1.5	0	0	
Aug	0	0	0	0	0	
Sept	0	0	0	0	0	
Oct	0	0	0	0	0	
Nov	0	0	0	0	0	
Dec	0	0	0	0	0	
Jan	0	0	0	0	0	
SHAGS-RESTING						
Month	ow+av	ow-av	ow,cd.cty	ow,fp	l.edge	
Mar	0	0	0	0	0	
April	0	1	0	0	0	
May	0	0	0	1	0	
June	0	0	1	1	0	
Aug	0	0	1	0	0	
Sept	0	0	0	0	0	
Oct	0	0	0	0	0	
Nov	0	0	0	0	0	
Dec	0	0	0	0	0	
Jan	0	0	8	1	0	
HERON-FEEDING						
Month	sw,cd.cty	l.edge	l.edm	l.edpe		
Mar	0	0	0	0		
April	0	0	0	0		
May	0	0	0	0		
June	0	0	0	0		
Aug	0	0	0	0		
Sept	0	0	0	0		
Oct	0	0	0	0		
Nov	0	0	0	0		
Dec	0	0	0	0		
Jan	0	2	0	0		

Appendix C

HERON-RESTING						
Month	sw	l.edge	l.edmu	l.edpe		
Mar	0	0	0	0		
April	0	0	0	0		
May	0	0	0	0		
June	0	0	0	0		
Aug	0	0	0	0		
Sept	0	0	0	0		
Oct	0	0	0	0		
Nov	0	0	0	0		
Dec	0	0	0	0		
Jan	0	0	0	0		
GREBES- FEEDING						
Month	ow+av	ow-av	ow, cd.cty			
Mar	2	1	0			
April	1	0	0			
May	1.2	2	0			
June	1.3	0	1			
Aug	0	0	0			
Sept	0	0	0			
Oct	2	0	0			
Nov	0	0	0			
Dec	0	0	2			
Jan	2	1	2			
GREBES-RESTING						
Month	ow+av	ow-av	ow, cd.cty			
Mar	1.5	0	0			
April	1.5	0	0			
May	1	0	0			
June	0	0	0			
Aug	1	0	0			
Sept	1	0	0			
Oct	2	1	0			
Nov	1.6	0	0			
Dec	2	0	0			
Jan	0	0	0			
GULLS & TERNS-FEEDING						
Month	ow+av	ow-av	ow, cd.cty	sw+av	sw-av	sw,cd.cty
Mar	0	0	0	0	0	0
April	0	0	0	0	0	0
May	0	0	0	0	0	0
June	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	0	0	0	0	0	0

Appendix C

GULLS & TERNS-RESTING						
Month	ow+av	ow-av	ow,cd.cty	sw+av	sw-av	sw,cd.cty
Mar	0	0	0	0	0	0
April	0	0	0	0	0	0
May	0	0	0	0	0	0
June	0	0	0	0	0	0
Aug	0	0	0	0	0	1
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	2	0	0	0	0	0

Appendix D

WAIMAKARIRI LAKES TOTAL BIRD CENSUS - DEPARTMENT OF CONSERVATION DATA

(Dec.87-Dec88)

LAKE GRASMERE

SPECIES	Dec.87	Jan.88	Feb.88	Mar.88	Apr.88	May.88	Jun.88	Jul.88	Aug.88	Sep.88	Oct.88	Nov.88	Dec.88
Cre.Grebe	10	1	12	6	3	4	1	0	4	4	4	4	4
Bl.Shag	1	0	6	0	1	1	1	2	0	0	0	0	0
Lit.Shag	0	1	5	0	2	0	1	0	0	0	1	0	0
W.f.Heron	2	0	0	0	0	0	1	0	0	0	0	0	1
Bl.Swan	52	67	87	72	111	96	101	66	27	26	15	21	47
C.Goose	75	125	1	250	0	1	411	202	16	88	7	38	32
Par.Duck	33	228	286	38	8	17	1	4	7	1	2	13	4
M.G.hybd	0	0	28	54	74	63	10	23	2	15	2	0	4
Scaup	95	54	214	73	194	97	163	62	85	52	29	49	43
Un.Duck	46	21	0	0	0	0	0	0	0	4	3	5	33
S.I.P.O	0	0	0	0	0	0	0	0	0	0	0	0	3
S.w.Plove	55	0	0	0	0	0	0	0	0	0	0	0	3
Bl.ba.Gull	3	2	3	0	0	0	0	0	0	10	0	0	24
Bl.f.tern	1	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	373	499	642	493	393	279	690	359	141	200	67	130	198

Appendix D

LAKE PEARSON													
SPECIES	Dec.87	Jan.88	Feb.88	Mar.88	Apr.88	May.88	Jun.88	Jul.88	Aug.88	Sep.88	Oct.88	Nov.88	Dec.88
Cre.Grebe	16	4	18	10	7	5	1	3	7	10	6	13	15
Bl.Shag	0	5	8	14	1	18	4	8	13	1	0	0	1
Lit.Shag	1	1	1	2	15	0	6	0	6	0	0	0	0
W.f.Heron	1	0	3	1	0	0	1	0	0	0	0	0	4
Bl.Swan	2	2	0	0	3	2	0	2	2	6	10	0	8
C.Goose	0	3	0	82	37	0	58	100	147	115	25	13	0
Par.Duck	18	4	2	12	5	2	36	18	14	4	10	9	14
M.G.hybd	3	0	6	2	20	30	82	11	51	31	25	0	0
Scaup	57	69	2	10	55	77	61	18	109	142	110	84	124
Un.Duck	0	0	0	0	0	0	0	0	0	2	2	0	1
S.I.P.O	0	0	0	0	0	0	0	0	1	0	3	0	0
S.w.Plove	4	0	0	0	5	0	0	2	0	3	3	0	9
Pied Stilt	2	0	0	0	0	0	0	0	0	0	0	4	8
Bl.ba.Gull	4	0	3	0	0	0	0	0	3	6	0	5	1
Bl.bi.Gull	0	0	0	0	0	0	1	0	0	0	3	0	0
Bl.f.tern	0	0	0	0	0	0	0	0	0	0	0	2	0
TOTAL	108	88	43	133	148	134	250	162	353	320	197	130	186

Appendix D

LAKE SARAH													
SPECIES	Dec.87	Jan.88	Feb.88	Mar.88	Apr.88	May.88	Jun.88	Jul.88	Aug.88	Sep.88	Oct.88	Nov.88	Dec.88
Cre.Grebe	4	2	6	2	3	0	0	0	0	3	3	3	3
Bl.Shag	1	0	0	1	0	0	3	2	0	0	0	0	0
Lit.Shag	1	0	1	0	0	0	0	0	0	0	0	0	0
Bl.Swan	4	4	1	0	8	5	5	7	13	4	17	44	34
C.Goose	0	12	1	0	0	0	0	90	16	0	5	0	4
Par.Duck	0	0	0	3	0	2	0	0	2	0	2	2	2
M.G.hybd	9	10	20	0	13	2	6	12	30	20	2	9	25
Scaup	57	38	90	61	31	54	22	70	78	35	51	59	51
Pied Stilt	2	0	0	0	0	0	0	0	0	0	0	0	2
Bl.f.tern	1	0	0	0	0	0	0	0	0	0	0	1	0
TOTAL	79	66	119	67	55	63	36	181	139	62	80	118	123

Appendix D

WAIMAKARIRI LAKES TOTAL BIRD CENSUS - DEPARTMENT OF CONSERVATION DATA												
(Jan.1989-Dec.1989)												
LAKE GRASMERE												
SPECIES	Jan.89	Feb.89	Mar.89	Apr.89	May.89	Jun.89	Jul.89	Aug.89	Sep.89	Oct.89	Nov.89	Dec.89
Cre.Grebe	3	6	4	3	3	0	1	1	3	0	0	3
Bl.Shag	0	0	1	0	0	0	0	0	1	0	0	0
Lit.Shag	0	0	0	0	0	0	0	0	1	0	0	0
W.f.Heron	0	0	0	0	0	0	0	0	0	0	0	0
Bl.Swan	70	44	78	99	112	85	112	77	34	0	0	25
C.Goose	75	57	260	356	469	351	334	142	363	0	0	36
Par.Duck	400	683	166	40	18	0	2	0	16	0	0	13
M.G.hybd	30	38	80	61	84	0	53	17	4	0	0	13
Scaup	94	74	158	152	123	152	300	90	66	0	0	104
Un.Duck	0	0	8	18	0	34	0	0	0	0	0	0
S.w.Plove	0	0	3	0	0	20	0	4	0	0	0	0
Bl.ba.Gull	0	0	0	0	0	0	2	1	0	0	0	0
Bl.f.tern	4	0	0	0	0	0	0	1	0	0	0	0
S.I.P.O.	0	0	0	0	0	0	0	4	0	0	0	0
Pied Stilt	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	676	902	758	729	809	642	804	333	488	0		194

Appendix D

LAKE PEARSON												
SPECIES	Jan.89	Feb.89	Mar.89	Apr.89	May.89	Jun.89	Jul.89	Aug.89	Sep.89	Oct.89	Nov.89	Dec.89
Cre.Grebe	16	16	19	16	10	3	6	4	12	0	0	10
Bl.Shag	3	2	0	1	5	3	4	5	1	0	0	2
Lit.Shag	2	0	24	13	8	7	6	6	4	0	0	0
W.f.Heron	1	2	1	1	0	2	0	0	0	0	0	0
Bl.Swan	0	4	14	2	2	10	2	2	5	0	0	31
C.Goose	0	18	250	0	179	135	146	169	13	0	0	35
Par.Duck	14	9	13	54	9	6	2	4	7			
M.G.hybd	11	8	13	38	57	0	67	0	1			
Shoveler	0	0	0	0	0	0	0	0	1	0	0	0
Scaup	30	39	1	121	55	140	128	122	93	0	0	90
Un.Duck	0	4	12	0	32	96	0	47	0	0	0	0
S.I.P.O	0	0	0	0	0	0	0	0	0	0	0	6
S.w.Plove	3	2	0	0	2	43	0	3	2	0	0	6
Pied Stilt	5	0	0	0	0	0	0	0	0	0	0	1
B.Dotteral	1	0	0	0	0	0	0	0	0	0	0	1
Bl.ba.Gull	3	1	0	0	0	3	4	2	6	0	0	2
Bl.bi.Gull	0	0	0	0	0	0	0	0	0	0	0	0
Bl.f.tern	12	2	0	0	0	0	0	3	0	0	0	0
TOTAL	101	107	347	246	359	448	365	367	178	0	0	266

Appendix D

LAKE SARAH												
SPECIES	Jan.89	Feb.89	Mar.89	Apr.89	May.89	Jun.89	Jul.89	Aug.89	Sep.89	Oct.89	Nov.89	Dec.89
Cre.Grebe	1	6	6	3	6	2	0	1	1			2
Bl.Shag	0	0	2	0	0	0	0	0	0			2
Lit.Shag	0	1	0	0	0	0	0	0	0			0
W.f.Heron	24	50	28	9	7	4	0	6	3			20
Bl.Swan	30	56	1	0	1	14	61	44	18			25
Par.Duck	0	10	1	2	0	0	0	2	0			0
M.G.hybd	132	131	108	70	0	23	0	29	5			7
Shoveler	0	0	0	0	0	0	0	0	1			0
Scaup	56	120	48	51	0	36	1	98	52			19
S.w.Plove	0	0	0	0	0	12	0	0	0			0
Pied Stilt	3	0	0	0	0	0	0	0	0			4
Bl.f.tern	0	0	0	0	0	0	0	0	0			1
TOTAL	246	374	194	135	14	91	62	180	80			80

Appendix D

WAIMAKARIRI LAKES TOTAL BIRD CENSUS - DEPARTMENT OF CONSERVATION DATA										
(Jan.1990-Dec.1991)										
LAKE GRASMERE										
SPECIES	Jan.90	Feb.90	May.90	Jun.90	Sep.90	Jan.91	Mar.91	Jun.91	Sep.91	Dec.91
Cre.Grebe	2	4	2	1		2	4	7	4	7
Bl.Shag	0	0	1	0	0	1	0	2	0	3
Lit.Shag	0	2	0	0	1	0	0	0	0	0
W.f.Heron	1	0	0	0	1	0	1	0	0	2
Bl.Swan	13	32	55	14	4	89	69	100	15	86
C.Goose	26	98	287	220	136	800	500	98	319	
Par.Duck	780	528	2	0	10	620	131	0	15	60
M.G.hybd	21	26	4	30	8	11	23	70	15	4
Scaup	173	79	34	119	49	174	45	200	44	131
Un.Duck	21	0	0	0	0	0	0	0	0	34
S.w.Plove	0	0	0	0	2	0	0	0	4	0
Bl.ba.Gull	0	0	0	0	1	0	0	0	0	0
Bl.f.tern	0	0	0	0	0	0	0	0	0	0
SIPO	0	0	0	0	5	0	0	0	4	0
Pied Stilt	2	0	0	0	0	0	0	0	0	0
TOTAL	1039	769	385	384	309	1033	1073	879	195	646

Appendix D

LAKE PEARSON										
SPECIES	Jan.90	Feb.90	May.90	Jun.90	Sep.90	Jan.91	Mar.91	Jun.91	Sep.91	Dec.91
Cre.Grebe	8	8	14	11	15	9	21	13	15	18
Bl.Shag	1	10	4	3			7	8	2	1
Lit.Shag			14	11	5		4	13	11	
W.f.Heron	2	5	1				5	1		2
Bl.Swan	2	1	5	1	4		2	1	21	2
C.Goose	1	13	34	190	122		179	115	115	33
Par.Duck		2	5	6		8	9		9	19
M.G.hybd		4	17	21	34		10	33	15	26
Shoveler										
Scaup	46	17	103	53	91	29	88	68	69	92
Un.Duck										
S.w.Plover		4	4	5	5	1	3		2	6
Bl.ba.Gull	4	4			5	13	1	2	20	
Bl.f.tern	1	1								2
SIPO					4					2
Pied Stilt										
Bl.bi.Gull		1								
TOTAL	65	70	201	301	290	60	329	254	281	205

Appendix D

LAKE SARAH										
SPECIES	Jan.90	Feb.90	May.90	Jun.90	Sep.90	Jan.91	Mar.91	Jun.91	Sep.91	Dec.91
Cre.Grebe	1	3			2	2	2		2	2
Bl.Shag	1	1			1					
Lit.Shag					1					1
Bl.Swan	14	6	2	1	11	17	12		16	7
C.Goose					36	15	13		14	
Par.Duck	1		2	2			2		5	1
M.G.hybd	13	77		12	2	4	22		6	1
Scaup	20	64			26	18	65		42	2
S.w.Plover					2	5				
Bl.ba.Gull	1								2	
Bl.f.tern										
SIPO										
Pied Stilt	2				4	2				2
TOTAL	52	151	4	15	85	63	116	0	86	16

Appendix D

Waimakariri Lakes, Total bird counts					
Jan.92-Dec.93					
LAKE PEARSON					
SPECIES	Mar.92	Jul.92	Dec.92	Apr.93	
Cre.Grebe	13	4	12	19	
Bl.Shag	5	2		5	
Lit.Shag	10	12		8	
W.f.Hern	2				
Bl.Swan	2	13	4		
C.Goose	8	59	27		
Par.Duck	2		5	6	
M/G.hybd	59	22	17	5	
Scaup	83	48	88	70	
Un.Duck					
S.w.Plover			2	6	
Bl.ba.Gull	2	1	2		
Bl.f.tern					
SIPO					
Pied Stilt			3		
TOTAL		186	161	160	119
LAKE GRASMERE					
DATE	Mar.92	Jul.92	Dec.92	Apr.93	
Cre.Grebe	3	2	4	3	
Bl.Shag	1	4			
Lit.Shag	5		1	1	
W.f.Hern					
Bl.Swan	46	93	91	121	
C.Goose	400	289	124	520	
Par.Duck	51	3	41	30	
M/G.hybd	33	48	20		
Scaup	60	153	102	98	
Un.Duck					
S.w.Plover				7	
Bl.ba.Gull					
Bl.f.tern					
SIPO					
Pied Stilt					
TOTAL		599	592	383	780

Appendix D

LAKE SARAH					
DATE	Mar.92	Jul.92	Dec.92	Apr.93	
Cre.Grebe	4		2	2	
Bl.Shag					
Lit.Shag			1		
W.f.Hern					
Bl.Swan	27		17	11	
C.Goose			13		
Par.Duck	1		1	4	
M/G.hybd	23		3	15	
Scaup	69		28	39	
Un.Duck					
S.w.Plover					
Bl.ba.Gull					
Bl.f.tern					
SIPO					
Pied Stilt			5		
TOTAL	124	0	70	71	

Appendix E

RECREATION DATA									
Data is number of people observed utilising the lake for recreation activity, predominantly during bird count sampling periods.									
LAKE PEARSON									
Month	Fishing	Camping	Picnicking	Boating	Jtbt/w.ski	Canoeing	Other w.s	Other	TOTAL
Oct.94	0	0	0	0	0	0	0	70	70
Nov.94	0	0	0	0	0	0	0	0	0
Dec.94	1	0	2	0	0	0	1	0	4
Jan.95	3	2	0	0	0	0	0	0	5
Feb.95	0	6	0	0	0	0	0	0	6
Mar.95	0	2	0	0	0	0	0	0	2
Apr.95	22	9	0	1	1	0	0	0	33
May.95	0	0	11	0	0	0	0	4	15
Jun.95	0	0	0	0	0	0	0	1	1
Aug.95	0	0	1	0	0	0	0	70	71
Sept.95	0	0	0	0	0	1	0	1	2
Oct.95	1	3	0	10	0	0	0	1	15
Nov.95	4	2	0	0	0	0	0	0	6
Dec.95	8	17	0	0	0	0	0	0	25
Jan.96	32	52	10	3	3	48	10	0	158

RECREATION DATA

Data is number of people observed utilising the lake for recreation acitivity, predominantly during bird count sampling periods.

LAKE GRASMERE

Month	Fishing	Camping	Picnicking	Boating	Canoeing	Other w.s	Other	TOTAL
Oct.94	0	0	0	0	0	0	0	0
Nov.94	0	0	0	0	0	0	0	0
Dec.94	3	0	0	0	0	0	0	3
Jan.95	5	0	0	0	0	0	0	5
Feb.95	0	0	0	0	0	0	30	30
Mar.95	6	0	0	0	0	0	0	6
Apr.95	0	0	0	0	0	0	0	0
May.95	0	0	0	0	1	0	0	1
Jun.95	0	0	0	0	0	0	0	0
Aug.95	0	0	1	0	0	0	0	1
Sept.95	0	0	0	0	0	0	0	0
Oct.95	0	0	0	0	0	0	0	0
Nov.95	0	2	0	0	0	0	0	2
Dec.95	3	0	0	0	0	0	0	3
Jan.96	1	0	0	0	0	0	0	0